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DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

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DIVISION OF BOTANY

REPORT OF THE DOMINION BOTANIST

H. T. GÜSSOW

FOR THE YEAR 1926

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GENERAL AND ECONOMIC BOTANY

Inquiries concerning various medicinal plants, their culture, and sale, continued to come in during the year 1926. Among those mentioned were blood-root, cascara, cat-mint, chamomile, ginseng, golden seal, marshmallow, mullein, peppermint, *Podophyllum*, rue, saffron, seneca-root, and spearmint.

There were also the usual inquiries about foods suitable for wild ducks and muskrats such as wild rice seed and muskrat potato (*Sagittaria latifolia* Willd.)

Miscellaneous inquiries dealt with chicory, extraction of iodine from kelp, pectoral flowers, etc.

The annual exchange list of seeds collected in the year 1925 contained the names of 1,203 species and varieties and was despatched to 117 foreign botanical gardens.

Altogether 3,522 packets of seeds were received during the year, mainly from botanical gardens but a few were received from private individuals also. Included in the above total were 284 packets of seeds received through the courtesy of the Director of the Arnold Arboretum, Jamaica Plain, Mass., which had been collected by Mr. J. F. Rock, at elevations of 8,500 to 12,000 feet on the mountains of China. Many of these were conifers but the collection comprised various others of possible economic importance such as *Berberis*, *Rhododendron*, *Lonicera*, *Syringa*, *Malus*, *Pyrus*, *Rosa*, *Rubus*, *Prunus*, *Grossularia* and *Ribes*. Included in the lot were also several herbaceous species such as *Iris*, *Primula*, etc. Part of this consignment was sown in the Arboretum while another part was sent to the Superintendent of the Experimental Station at Morden, Manitoba, for testing in that province.

In exchange for the above, 5,177 packets of seeds and 88 species of roots and cuttings were sent out, partly to foreign botanical institutions and partly to private individuals mainly resident in Canada. The largest consignment despatched to a single institution comprised 333 packets which were sent to the Boyce Thompson Institute, Yonkers, N.Y. Next in point of size was a consignment of 294 packets for Rio de Janeiro, Brazil, followed by 284 packets for the Institute of Applied Botany at Moscow, U.S.S.R. In addition 52 packets were forwarded to Disco Station in Greenland; a package of seeds of Sugar Maple was sent, on request, to a missionary in Tibet. A considerable number of packages of Wild Rice seed and roots of various medicinal plants, such as Peppermint, Marshmallow, etc., were sent to various localities in Canada.

In response to various enquiries relating to literature dealing with the wild flowers of Canada, Bulletin No. 58, New Series, entitled "A Survey of Canadian plants in relation to their environment," was published during the year.

The series of experiments initiated two years ago on the germination of the seeds of some fleshy-fruited plants under the influence of various climatic conditions was concluded. Seeds of over fifty species of plants with fleshy fruits were tested for germination. The species employed comprised not only wild plants but also *Asparagus*, *Convallaria*, *Crataegus*, *Cucumis*, *Lycopersicon*, *Prunus*, *Ribes*, *Rubus*, and *Vitis*.

The tests were of four kinds. (A) The seeds after separation from the pulp were sown out of doors and left there during winter. (B) The seeds were sown on the same date as (A), but they were planted in pots in a greenhouse. (C) The seeds after separation and drying were enclosed in a tin box, stored in a dry place out-of-doors, and planted in spring. (D) The dry seeds were stored indoors at room temperature and planted in spring.

The best results were obtained in lot A in 23 species, while lot B came next with 13 species. The effect of exposure to cold in lots labelled (A) was most marked in the genera *Actaea*, *Aralia*, *Ribes*, *Symphoricarpos*, and various genera of *Liliaceae*, such as *Convallaria*, etc.

The genera *Asparagus*, *Celtis*, *Lycopersicon*, and *Rubia* gave a higher germination when sown immediately in a greenhouse, than they did when left in the open ground during winter. The same four species gave still better results after being kept dry for 5 months.

Storage of the dry seeds at a low temperature had no advantage over storing at room temperature.

SYSTEMATIC BOTANY AND WEED STUDIES

The reference herbarium of the Division continues to receive attention and was enriched during the year by the addition of some hundreds of specimens, mostly collected in substantiation of the more important weed records obtained in our field work. We have also to acknowledge gratefully the donation, by Miss J. Bostock, of about 150 mounted and labelled plants from Summerland, B.C.

Correspondence relating to weeds, poisonous plants, and wild plants generally, and identification of many hundreds of plants for correspondents claimed the usual considerable amount of time. Extension work through articles and public addresses was done as there was occasion.

Some new experimental work with weeds was undertaken, and the furtherance of the Canadian weed survey project was given all possible attention. Enough has been attempted during the past few years, to point the way to endless fruitful and needed lines of investigation. The weed problem in all parts of Canada is steadily growing in magnitude, as indicated by one province's recent revision of its estimate of its annual loss from \$25,000,000 to \$30,000,000. Some of the provinces have been assuming a large measure of responsibility for their own weed problem, even in the field of experimentation, but others remain quiescent in the face of the growing menace. While this state of affairs continues, there is need, not only to work for the solution of special difficulties in the control of certain weeds, but, perhaps even more, to bring to light the actual situation existing in each locality, the more threatening by reason of unsuspected or disregarded newer weeds which are constantly entrenching themselves. The facts which have already been brought together through the Canadian weed survey, on close to 1,000 plants of all degrees of weediness, are now being used to create local concern over weed situations peculiar to a locality, as well as of a more general nature; and, when once they can be put to work in a larger way, they can be made a real force in arousing the whole country to a realization of its duty in the matter. After all, it remains for those immediately concerned to deal with their own weed problems, under direction it may be, but still under local or personal auspices; for no government service has the stake in the outcome that they have, nor the resources to take it out of their hands.

TESTING HOFER'S CHARLOCK POWDER

At the request of the Canadian distributors of Hofer's Charlock Powder, quite a few tests were made of this Danish preparation to determine its worth as a weed control agent on Canadian farms. Two hundred pounds of the material were received at the Central Experimental Farm, and like amounts at the Brandon Morden, and Fredericton farms.

Hofer's Charlock Powder is a dust preparation intended for application on a dewy leaf surface. It is stated to be a mixture of ferrous sulphate or green vitriol and calcium sulphate or gypsum. Ferrous or iron sulphate has been for

years successfully employed as a spray material against mustard, but without coming into any general popularity among farmers.

The powder was received in ample time for use on mustard and other annual weeds starting in spring grain, but only after most perennials and weeds in undisturbed ground had made considerable growth. It was not, however, until rather late, on June 8, that suitable weather, with the required heavy dews, was obtained. Tests were carried out on that date, and on June 11, 16, 21, and 28, as weather was favourable. Applications were made at various times from 4 a.m. to 8 a.m. by which time dew was seldom sufficient for a good test. One application was made on vegetation wet with rain, and another preliminary test was conducted in the greenhouse on seedlings sprinkled lightly with water before dusting, results in these cases proving comparable with those on dew. In all 20 tests were made, at different rates of application, by several different means of application, and upon some 60 different weeds, some species only once, and others up to as many as eight times. Notes were taken on all these experiments, and might be presented in some detail here, but it is felt that many of the results need to be supported by further tests, especially as difficulty was experienced in getting even application of the dust.

Definite weights (at the rate of 160 and 320 pounds per acre) of the powder were used on measured fortieth acre plots, but, even when the plots were crossed in two directions, there was apt to be unevenness of result. A horticultural dust-blower was used in most experiments; and a sifting bag of mosquito netting, as well as broadcasting by hand, were tried without entire success. For field operations suitable machinery would be necessary, and may have to be first perfected before dusting can be practised satisfactorily in any large way.

OBSERVATIONS AND CONCLUSIONS.—Among the weeds present in the plots dusted were some which could not be expected to take much injury. Couch and other grass weeds, as also the cereal crops themselves, have narrow smooth leaves, and a growing point well protected within the sheathing leaves. Other weeds which appeared to be especially resistant were toad-flax, annual and perennial sow thistles, horsetail, knotgrass, curled dock, field bindweed (*Convolvulus*), purslane, lamb's quarters, burdock, ox-eye daisy, tufted vetch, and white clover.

Various weeds will be omitted from mention, because only slightly injured, or in too few and inconclusive tests, or too far past the seedling stage. Some weeds may be injured more or less as young plants, but not later. Where injury was slight, it was in some cases at the lighter application, when the heavier might have been effective.

Some perennial weeds were readily enough deprived of their foliage, but promptly recovered and would have required repeated treatment to starve the root system. Canada thistle, dandelion, mouse-ear chickweed, and self-heal are examples. A part of the difficulty arises, too, from the fact that the leaves receiving the dust usually shelter other leaves beneath, and the plant receives only a slight setback. This may be sufficient in some cases to give the crop the lead necessary to take care of itself, but with dandelion in a lawn, for instance, is useless, unless followed up by another application very shortly.

The results with a number of the annual weeds were encouraging enough to warrant plans for further experimenting to determine the best rates and methods of application. Wild mustard (and in the Fredericton tests, wild radish) proved quite susceptible in early stages of growth, with amounts of the powder safe to the grain, and perhaps not too expensive for general use. Hemp nettle, Canada fleabane, perhaps stinkweed, and at least the seedlings of ragweed and some other mustards, were also injured enough to be worthy of further tests.

It would be premature yet to advocate the substitution of this dust method for the older spray method of applying iron sulphate. Either will destroy wild

mustard (and wild radish). The choice of method is rather one of convenience and practicability and relative cost, which, for material at least, is much less in the case of iron sulphate. Little can be said as to the relative cost of outfit for applying, until we know better what dusting outfits may be devised. Dusting obviates the necessity for laborious handling of water, but, on the other hand, is restricted to a few early hours of the day, which, for many farmers, would be out of the question, and in any case is too subject to meteorological conditions to allow of definite planning ahead. The tendency will be to take chances with insufficient dew, and sunshine following; or to attempt dusting of weeds, whose treatment has been delayed too long; or to neglect treatment altogether, when spraying might have been carried out according to intended schedule. This year's experience indicates that there may be somewhat less difficulty in the coastal provinces, than in the interior, in getting dusting done efficiently and on time.

CANADIAN WEED SURVEY

The work of consolidating our records has progressed to a point where it is estimated that upwards of 25,000 cards are now on file for ready reference. From these records, weeds of importance, like perennial sow thistle, can now be charted for all Canada, with some degree of accuracy.

Field work this year extended the surveys already made in the eastern half of Canada, through Quebec, following down the St. Lawrence river, and through the three Maritime Provinces. A period of two weeks, or about a third of the time, was devoted to a somewhat more detailed survey of Prince Edward Island, selected as a convenient unit for the purpose. All parts of the province accessible by rail, and others reached by automobile, were visited, so that notes were obtained more or less fully in 55 of the 74 lots and towns. About 240 plants, included in the Canadian weed list, to which may be added about 50 others not seen personally but recorded by competent observers, are, therefore, our present provincial weed list. This is considerably less than one-third of the species now constituting the Canadian list.

Below are some of the more important weeds (mostly such as are named in the Seeds Act of Canada), given in the order of their observed prevalence, which is not necessarily the order of their importance:—

Yarrow (the only weed recorded in every place)	Spurrey	} Once or twice each
Fall dandelion (often locally August flower)	Wild buckwheat	
Brake fern or bracken	King Devil	
Ox eye daisy	Upright cinquefoil	
Canada thistle	Common chickweed	
Tall buttercup	Wild radish (at stage apt to be overlooked)	
Brown top	Toad flax	
Tufted vetch	Bitter dock	
Daisy fleabane	Wild mustard (at stage apt to be overlooked)	
Curled dock	Orange hawkweed	
Shepherd's purse	Black medick	
Dandelion	Water hemlock (spotted cowbane)	
Sheep sorrel	Sweet clover	
Lamb's quarters	Tumbling mustard	
Couch grass (probably often overlooked)	Bladder campion	
Low cudweed	Chicory	
Common plantain	Green foxtail	
Common mouse-ear chickweed	Common ragweed	
Evening primrose	Ribgrass (buckhorn)	
Mouse-ear hawkweed (often locally lemon hawkweed)	Night-flowering catchfly	
Perennial sow thistle (including a colony of the smooth form)	Blue bur (Lappula)	
Black-eyed Susan or coneflower	Stinkweed	
Burdock	Purple cockle	
Common or tansy ragwort (stinking Willie, Baughlan)	Giant ragweed	
	White cockle	

It is, of course, to be understood that one survey in midsummer does not find weeds all at the stage of development to best show their prevalence; neither are weeds at any time all equally conspicuous. Nevertheless it is felt that the method followed of repeating survey lists, at frequent suitable intervals of travel, must give, not only a complete record of the species encountered, but also a fair approximation of their relative prevalence. The relative importance is another and more difficult study which must take into account, among other things, the weed's choice of habitat both as to soil and crop, numerical abundance, size and ability to crowd crop plants, resistance to control measures, facilities for dissemination and for carrying over seasonally, and poisonous or other injurious properties. The Prince Edward Island survey is to be the subject of a more detailed separate treatment.

PLANT PATHOLOGY, CENTRAL LABORATORY

EXAMINATION OF PLANT IMPORTATIONS

In the last annual report of the Dominion Botanist, under the above heading, a brief description was given of the extent to which the Division of Botany participates in this phase of work. In addition, mention was made of the difficulties encountered in making diagnoses of the unsound material found in shipments of ornamental stock, particularly the bulbs, corms, rhizomes, and tubers. It was pointed out that in order to give well-based opinions as to the disposal of shipments containing unsound material, some research work should be conducted into the causes of these troubles and their economic importance.

Considerable time was spent in the examination and reporting on specimens taken from foreign shipments, and the making of cultures from unsound material, in an effort to determine the cause of these injuries. The number of samples taken from intercepted shipments and submitted to this Division for examination was much larger than in any previous year. They amounted to 413, representing 32 plant genera, from 13 different countries. This material was largely composed of the bulbs, corms, rhizomes, and tubers of ornamental plants, the remainder being fruit, vegetables, and nursery stock.

In May and September visits were made to Montreal in order to expedite the inspection of large shipments of bulbs, and to become familiar with the methods employed in the inspection of foreign shipments. In the fall, when the bulk of the bulb shipments from Holland arrive, an inspector of the Division of Botany was sent to Montreal to assist with this work.

All of the intercepted bulbs of each kind were carefully examined with a hand lens and divided into types of injury. Each type was then photographed, specimens preserved in formalin, some were planted out-of-doors, some were potted and grown in the greenhouse, and numerous isolations of probable causal organisms were made. This separation into types of injury was only arbitrary; they would not necessarily represent distinct diseases, as some may prove to be merely of mechanical nature, while others may be different stages of the same disease as occurring on different varieties. The accompanying photographs (plates 1-4) illustrate some of these types.

In making isolations from material of this kind which has been subjected to all the varying conditions of storage and transportation, it is obvious that any tissue injured by the activities of some pathogenic organism or by mechanical injury, would be quickly invaded by a large number of saprophytic fungi, bacteria, mites, etc. In some instances, these saprophytic organisms could not be eliminated even by the most careful methods and frequent repetition.

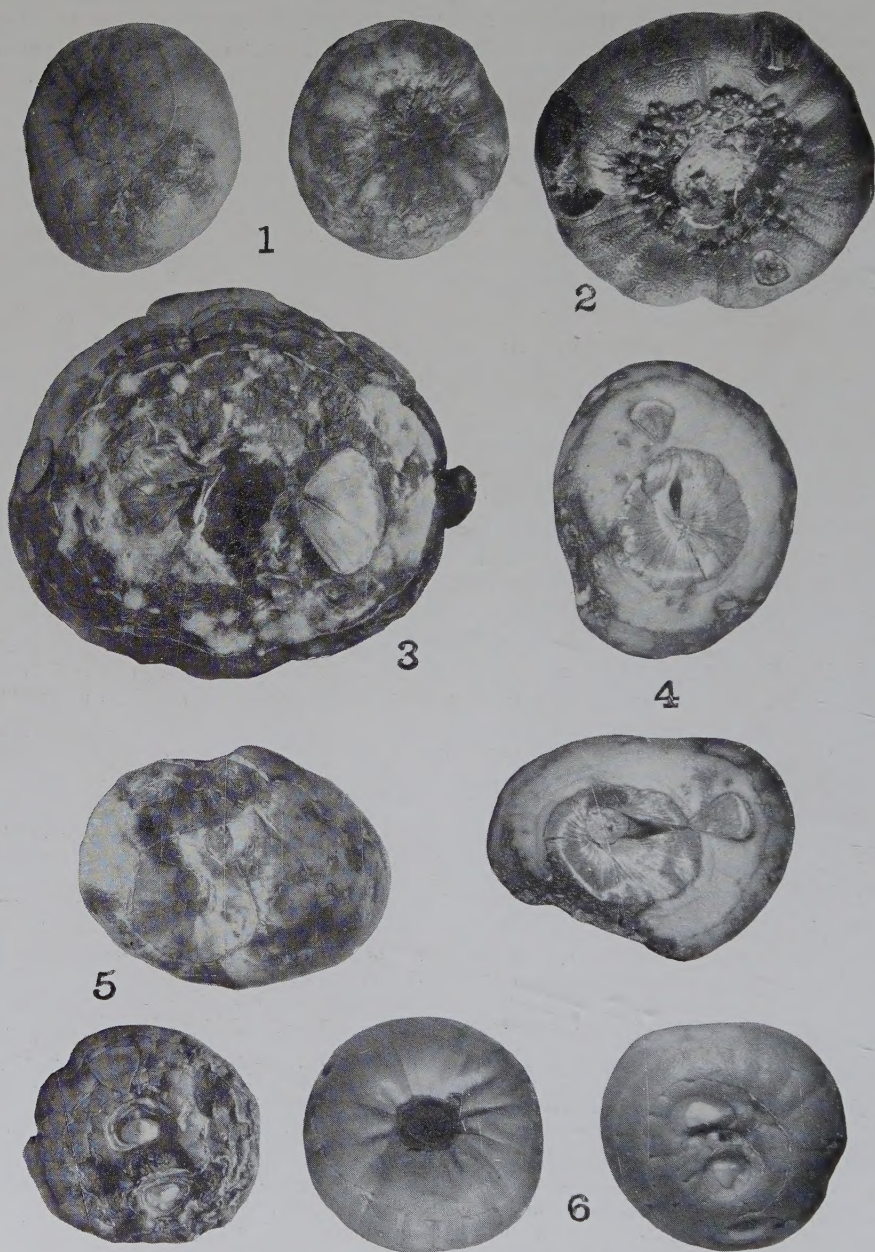


PLATE 1.—TYPES OF DISEASE IN GLADIOLUS CORMS

Fig. 1.—Two corms affected with dry rot (*Sclerotium* sp.)

Fig. 2.—Scab or neck rot (*Bacterium marginatum* McC.)

Fig. 3.—A storage rot caused by a sclerotium-bearing fungus of the *Botrytis* type.

Fig. 4.—Two corms decayed by an unidentified species of *Fusarium*.

Fig. 5.—Two corms affected with hard rot (*Septoria Gladioli* Pass.)

Fig. 6.—Two healthy corms.

(Photos by F. L. Drayton)

From a large amount of material of some fourteen kinds of bulbs, corms, etc., 53 types of injury were segregated, and from these, 52 probable causal organisms were isolated. Several of these cultures were identified as the causes of diseases already described. These were as follows:—

Septoria Gladiola Pass.—gladiolus hard rot.
Bacterium marginatum McC.—gladiolus scab.
Sclerotium sp.—gladiolus dry rot.
Botrytis Tulipae (Lib.) Hop.—tulip fire disease.
Rhizoctonia Tuliparum (Kleb.) Whetz. et J. M. Arth.—tulip grey bulb rot.
Botrytis polyblastis Dowson—cne of the narcissus ball rots.
Bacterium Hyacinthi Wakker—hyacinth yellow disease.
Botrytis Paeoniae Oud.—peony blight.

The other cultures have not so far been identified. It is hoped that in a few years concise information will have been obtained as to the causes and relative importance of these troubles, so that in the inspection of plant importations, it may be possible to recognize the diseases which are of importance and exclude the shipments in which they are found.

GLADIOLUS DISEASES

The field experiments on the control of the gladiolus dry rot disease (*Sclerotium* sp.) were continued this year, and a number of new substances were tried both as corm treatments and soil applications. The following is an outline of the experiments:—

1. Corms free from disease were planted in soil in which a large number of diseased plants had grown in 1925. The following three substances were broadcasted in the bottom of the trench and on the soil thrown up at the side. The bottom of the trench was then harrowed and the corms planted.

- (a) Bayer Dust, at the rate of 12 ounces per 20 feet of trench.
- (b) Semesan Jr. at the same rate.
- (c) Flowers of sulphur, at the rate of 20 ounces per 20 feet of trench.

2. Corms having dry rot lesions were planted in soil which had borne a diseased crop in 1925. In this case the corms were soaked in disinfectants, and then dusted with a fungicide in the hope of protecting the plants from soil infection.

- (a) Soaked in 0.5 per cent Uspulun for 5 hours, drained, and the moist corms dusted with Bayer Dust.
- (b) Soaked in 2 per cent Uspulun for 7 hours and dusted with Bayer Dust.
- (c) Soaked in 2 per cent Semesan for 7 hours and dusted with Semesan Jr.
- (d) Soaked in 5 per cent formalin for 5 hours and dusted with sulphur.
- (e) Soaked in 1 in 1,000 mercuric chloride for 5 hours and dusted with sulphur.

3. Corms free from disease, but selected from lots which had diseased corms in them, were planted in soil which had borne a diseased crop in 1925. The corms were treated with a combined soak and dust as follows:—

- (a) Soaked in 0.5 per cent Uspulun for 5 hours, drained, and dusted with Bayer Dust.
- (b) Same as (a), but soaked in 2 per cent Uspulun for 7 hours.
- (c) Soaked in 2 per cent Semesan for 7 hours and dusted with Semesan Jr.
- (d) Soaked in 2 per cent formalin for 5 hours and dusted with flowers of sulphur.
- (e) Soaked in 1 in 1,000 mercuric chloride and dusted with sulphur.
- (f) Soaked in water and dusted with sulphur.

4. Corms free from disease, but selected from lots which had diseased corms, were planted in soil which had never grown diseased plants, after being treated in the following way:—

- (a) Soaked in 0.5 per cent Uspulun for 5 hours.
- (b) Soaked in 2 per cent Uspulun for 7 hours.
- (c) Soaked in 2 per cent Semesan for 7 hours.
- (d) Soaked in 5 per cent formalin for 5 hours.
- (e) Soaked in 1 in 1,000 mercuric chloride for 5 hours.
- (f) Moistened with water and dusted with sulphur



PLATE 2.—SIX TYPES OF UNSOUND TULIP BULBS FOUND IN FOREIGN SHIPMENTS.

(Photos by F. C. Hennessey.)

5. Corms with dry rot lesions planted in soil which had never borne diseased plants. The corms were treated as follows:—

- (a) Soaked in 0.5 per cent Uspulun for 5 hours.
- (b) Soaked in 2 per cent Uspulun for 7 hours.
- (c) Soaked in 2 per cent Semesan for 7 hours.
- (d) Soaked in 5 per cent formalin for 5 hours.
- (e) Soaked in 1 in 1,000 mercuric chloride for 5 hours.
- (f) Moistened and dusted with sulphur.
- (g) Soaked in hot water (125° to 130°F.) for 30 minutes.

(These corms did not grow.)

In every experiment there was a check of untreated corms or soil. The results were discouraging in that no marked control was obtained by any of the treatments. The check plants in the various experiments yielded an average of 89 per cent diseased corms, and the plants from treated corms and soil, an average of 61.8 per cent. These results refute the claims which are made for the value of certain organic compounds of mercury in the control of gladiolus diseases. The treatments that showed some promise will be repeated with stronger solutions next year, as well as with some new substances which are recommended as good soil disinfectants.

The three gladiolus diseases, dry rot (*Sclerotium* sp.), hard rot (*Septoria Gladioli* Pass.), and scab (*Bacterium marginatum* McC.), (see Pl. I, Figs. 1, 2, and 5) are similar in that they are carried over both in diseased corms and in soil which has borne diseased plants. Based on our present knowledge of these diseases, the following recommendations for their control are made:—

1. Areas in which diseased plants have grown should be avoided for the future planting of gladioli for as long a time as possible, and every precaution must be taken to prevent the transference of such soil to clean areas, either by cultivating tools, ploughing machinery, by the feet of men or animals, or by wind in the case of a soil that is liable to drift.

2. Corms having lesions should under no circumstances be planted or sold, because this constitutes the most prominent means of introducing the causal organisms into a soil which may be free from them. In order to make sure that the corms are free from lesions it is necessary to remove the corm scales completely. This can be done either just before planting, or during March and April, provided that the corms from which the scales have been removed are stored until planting time with layers of some such material as peat moss between them in the containers, and kept as near as possible to the ideal storage temperature of 40° to 45° F. If this is not done the corms which have had the scales removed will shrivel.

This recommendation is open to criticism. It would entail a great deal of work in the case of a large grower, but we must strongly recommend this tedious procedure, especially in the case of newly purchased or valuable varieties. Where gladiolus culture is carried on extensively, the work of peeling all corms would render it almost prohibitive. From field experience, however, we are enabled to make further suggestions that might assist where scaling is not practicable.

3. During the growing season, when cultivation or flower cutting is being done, a sharp lookout should be kept for all plants showing the first symptoms of disease, i.e., a leaf yellowing or spotting. When such a plant or group of plants is found, they and the surrounding soil should be immediately removed with a spade, placed in a box or wheelbarrow kept at the end of the rows, and disposed of in such a way as to preclude all possibility of contaminating clean soil. With the exception of an occasional drying of the leaf tips in hot weather, any deviation from the normal green colour of the leaves, in a climate similar to that of Ottawa at any rate, should be regarded as an indication of the presence of disease, and dealt with accordingly. Even the first two or three frosts in the fall have no appreciable effect on the leaves.



PLATE 3.—SIX TYPES OF DISEASE FOUND IN FOREIGN SHIPMENTS OF NARCISSUS BULBS.

(Photos by F. C. Hennessey.)

Early ripening of the plants may occur in certain varieties in locations where planting is done early and dry weather prevails in the latter part of the season. Care must be taken to ascertain, however, that the early ripening is not due to disease; it can only be a normal condition, when it is uniform throughout the variety, and in the absence of any of the disease symptoms described above.

4. At digging time a further opportunity is offered to get rid of diseased plants and their cormels. Any plants which, on being dug, show any signs of decay on the stems or discoloration of the corm scales, should be placed in a separate container and suitably disposed of. While diseased corms may be later distinguished, it is impossible, as has been indicated previously, to separate the respective cormels of healthy and diseased plants, although the latter are capable of carrying the fungus and infecting soil when planted. The two recommendations last given offer an easy way of avoiding this source of contamination, which is one of great importance, and one which, if overlooked, will result in a spread of the disease, however careful the inspection of corms and quarantine of diseased soil may be.

5. When cleaning the corms in the winter another opportunity is afforded to eliminate diseased specimens. The lesions are usually seen in the lower half of the corm, and, if not, discolorations of the corm scales with corresponding lesions below will be seen. The corm so affected should be discarded.

6. The use of various disinfectants for treating diseased corms and diseased soil has been tried without success so far. We should, however, recommend the use of a 5 per cent solution of formalin for 30 minutes, or a 1 in 1000 solution of corrosive sublimate for 15 to 20 minutes in the two following cases:—

- (a) For soaking healthy corms selected from a mixture of healthy and diseased ones.
- (b) For soaking corms of expensive varieties after the lesions have been cut out with a knife.

7. The inspectors at the ports of entry are now familiar with these diseases, and a more careful search is being carried out in imported gladiolus stock. A percentage of disease will be set, above which the shipment will be condemned, and if any disease is found in a shipment permitted entry, the grower will be notified of its presence and the necessary precautions to adopt.

The growing of gladiolus corms commercially has increased of recent years until it has become an industry of some importance. In 1926 over ninety individuals and companies have devoted all or most of their time to this work, on an area estimated at 200 acres. These figures appear to be insignificant, but it must be remembered that it takes upwards of 50,000 corms to plant an acre, the wholesale value of which would vary from 3 cents to \$5 a corm, depending on the varieties grown, so that the money invested in this crop per acre greatly exceeds that in any of the farm crops. Owing to the destructive nature of gladiolus diseases, it would seem advisable to establish some form of inspection and certification service in order to help the growers and aid the purchaser in the procuring of disease-free stock. If this industry is to continue as a profitable one and the popularity of the flower is to be maintained, it is essential that these diseases be prevented from becoming established in gardens and commercial plantations.

THE MYCOLOGICAL HERBARIUM

During the past year considerable time has been spent in arranging this collection. The specimens, approximately 35,000 in number, were first sorted into temporary genus folders, and then mounted on sheets which are held loose-

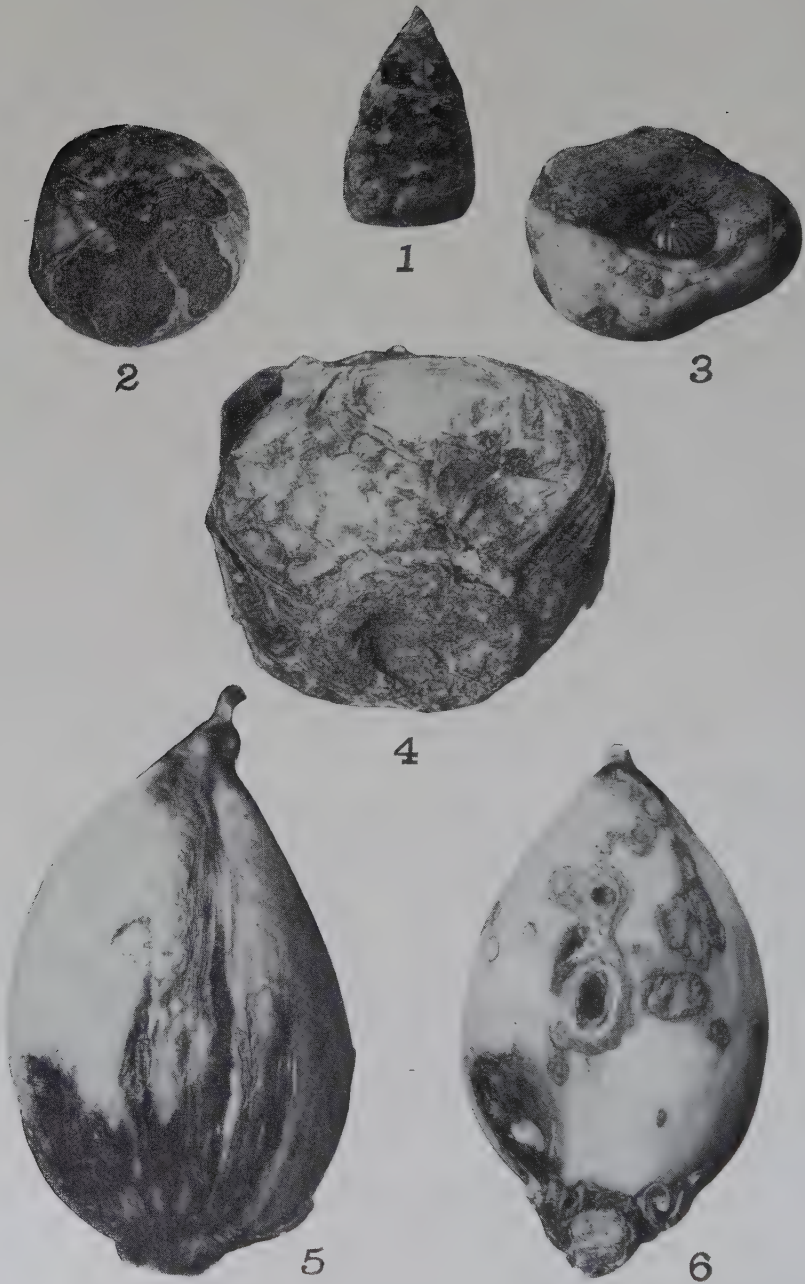


PLATE 4.—TYPES OF DISEASED BULBS TAKEN FROM FOREIGN SHIPMENTS

Fig. 1.—Freesia corm.

Figs. 2 and 3.—Crocus corms.

Fig. 4.—Hyacinth bulb.

Fig. 5.—English Iris bulb.

Fig. 6.—Spanish Iris bulb.

(Photos by F. C. Hennessey.)

leaf in books specially made for the purpose. When this is completed a parasite and host card index will be made, which will refer to the volume, page, and specimen numbers.

At present 981 genera are represented in the herbarium; of these 733 are now mounted in 188 volumes. The genus *Puccinia* contains the largest number of specimens, 534 species being represented. At the same time that the specimens are being mounted, lists are made of the species and their hosts contained in each volume, so that at the present time a large proportion of the herbarium is accessible alphabetically as to fungus species only. These lists will ultimately be used in making the parasite and host card index.

Our collection is a most valuable one, and has been assembled by purchases, gifts, exchange, and collections by members of our staff. It consists of the following types of material:—

1. The specimens collected by members of the Division of Botany.
2. Mycological contributions of the Victoria Memorial Museum, consisting mainly of a large amount of material collected by the late John Macoun, and largely identified or checked by specialists in the groups concerned.
3. Large collections from the United States Department of Agriculture and certain State collections.
4. A collection purchased in Sweden, covering the Scandinavian countries and small collections from other European countries.
5. Fungi Columbiani—Centuries 1 to 51.
6. Kuntze Fungi Selecti—Centuries 1 to 4.
7. Economic Fungi, Seymour and Earle—Nos. 1 to 550.
8. Mycotheca Italica—Nos. 1 to 1750.
9. Linhart Fungi Hungarici—Centuries 1 to 5.
10. Rehm Ascomyceten—Nos. 1051 to 1575.
11. Plantae Cryptogamicae in Arduenna—Fascicles 1 to 4.
12. North American Fungi, Ellis and Everhart—Nos. 2701 to 2900.
13. Fungi Bavarici, Allescher and Schnabl—Centuries 5 and 6.
14. Romell Fungi Scandinavici—Centuries 1 and 2.
15. Fungi Rossiae—Fascicles 1 to 5.
16. Rabenhorst Fungi Europaei—Nos. 1200 to 1300 and 4101 to 4300.
17. West American Fungi, Griffiths—Centuries 1 to 4.
18. Kansas Fungi, Kellerman—Nos. 1 to 50.
19. Ohio Fungi, Kellerman—Nos. 1 to 200.
20. New York Fungi, C. L. Shear—Centuries 1 to 6.
21. Fungi Malayana—Centuries 1 to 6.
22. Vestergren Micromycetes rariores selecti (incomplete).
23. Flora exsiccata Austro-Hungarica (incomplete).
24. Flora Hungarica exsiccata (incomplete).

This Mycological Herbarium may be consulted at any time at the Central Office by any mycological worker, and the loan of any specimens may be arranged for by application to the Dominion Botanist.

FOREST PATHOLOGY

WHITE PINE BLISTER RUST

IN EASTERN CANADA.—During the present year a survey in connection with this disease was undertaken in the country lying adjacent to the Ottawa River from Pembroke west to North Bay, north from Mattawa towards Lake Kipawa, north from North Bay as far as Temagami, and part of the French river district. The purpose of this work was to study the occurrence of *Ribes*, especially with a view towards estimating the cost of eradication in this part of the province. The district under consideration contains some very fine stands of young white pine which are well worth protecting.

Briefly, the method adopted was to select representative plots in different types of forest and to count the number of currants and gooseberries growing there, at the same time taking complete notes on the topography, forest cover, ground cover, and soil. In all 67 such plots were established, most of which were $\frac{1}{8}$ of an acre in area. Probably more reliable results would have been obtained had long strips been run instead of using the plot method. The data secured by the latter are more apt to represent extreme conditions, while the former yield average figures.

The following species were found to occur:—

Ribes glandulosum
R. triste
R. lacustre
R. rotundifolium

R. Cynosbati
R. prostratum
R. oxyacanthoides
R. hudsonianum

During the course of the field work no infection was found on currants, though frequently on gooseberries. *Ribes oxyacanthoides* was found to be the most widely distributed gooseberry. *R. Cynosbati*, so common in the eastern part of the territory worked in, gradually dropped out to the west and north. In the Mattawa district only a few plants of the smooth gooseberry were found, and north of Mattawa and of North Bay no gooseberries at all were observed.

The currants were much more widely distributed. They were present throughout the district as far north as work was carried on and where gooseberries were not found. *Ribes glandulosum* is the most common, occurring in all forest and topographical types excepting bog. It is tolerant to dry conditions, and is abundant generally in moist locations. It is also found in the open and under dense cover.

The country worked over was classified into the following types: bog, barrens, white pine, birch-poplar, conifers, mixed hardwoods and conifers, and hardwoods. The latter three contained the greatest number of *Ribes*. None were found in bog, while in the remaining three *Ribes* were only moderately numerous.

While the principal object of this study was to gather information upon which to base an opinion as to the probable cost of eradication, no actual eradication was done. The results of such work would be very misleading, as costs would be abnormally high, chiefly owing to lack of experience. In addition, the fact, that only a very small area could be covered, would tend to yield much higher costs than would be obtained, if a large area were worked over. The only basis, then, upon which to make an estimate is the result of such work in the United States in similar types of country. For this purpose the officials of the Blister Rust Control Office of the United States Department of Agriculture have briefly placed all available data at our disposal, and the fact that two of these officials have travelled through the district in question and know something of conditions there makes their opinions more valuable.

In the United States, systematic eradication of *Ribes* has been practised since 1918. Between 1918 and 1925, inclusive, approximately 4,000,000 acres were worked over in the Northeastern States at an average cost of 22 cents per acre. Each year, as experience was gained and methods improved, the costs were reduced. It is probably true that our conditions in general are more difficult so far as eradication is concerned, and that the only way to secure reliable cost figures is through actual work on a large scale; but there are certain areas which are more or less comparable.

For instance, the district about North Hudson, Essex County, New York, in the Adirondacks, is one which presents many difficulties in the way of eradication. There is a large number of *Ribes* present—an average of 137 to the acre,—the topography varies from swamp to mountainsides, and there is a wide range of types. In a demonstration control area established there, 673 acres were eradicated at an average cost of \$1.83 per acre. Conditions in general

are less difficult in Ontario than at North Hudson. At Wolfboro, New Hampshire, 845 acres were eradicated at an average cost of 69 cents per acre. The conditions there seem to be fairly similar to those in the part of Ontario under consideration. In both cases it should be remembered that, when work is done over a considerably large area, the costs will be reduced.

With these facts in mind, it does not seem unreasonable to expect that eradication in Ontario might be carried on at an average cost of approximately one dollar per acre, after men have been trained to such work and after it has been well organized. The fact that this territory is not well traversed by roads would make transportation a little more complicated, but would not necessarily increase costs greatly.

IN BRITISH COLUMBIA.—In the spring of this year conditions appeared to be very favourable for the development of rust. Rainfall was abundant and the season was more advanced than usual with a consequent early maturing of *Ribes* leaves. On pines aecial production was initiated at an early date but, instead of continuing normally on an increasing scale, it became retarded as the season advanced. As a result aecial production for this year was lighter than usual. At Pender Harbour, Qualicum Beach, and other places on the coast where, in former years, infection was abundant, it was only found this year with much difficulty. In the interior at Kelowna and Merritt lighter infection was also the case. However, the uredinial spread resulting from comparatively small initial aecial infection was considerable, and probably a good deal of pine infection occurred as a result. No favourable year for pine infection has occurred on the coast since 1920 and 1921, and in the interior since 1922. In the latter year, as shown at Canoe, Revelstoke, and Beaton, conditions were very favourable. Since then the disease on the pines has made little progress.

In the Kootenay country the two principal species of native *Ribes* are *R. viscosissimum* and *R. lacustre*. *R. petiolare*, while less abundant, is the most susceptible to rust. *R. viscosissimum* is more susceptible than *R. lacustre*, and produces a greater number of teliospores. As yet, however, it is not possible to say which might be expected to do the most damage, as the distribution and frequency of occurrence of the different species are not known. On the coast *R. bracteosum* is the most susceptible species and is doing the most damage.

At Daisy Lake there is more severe pine infection than at any other point in the West. With respect to damage, it now appears that trees up to 90 feet in height will soon lose their tops in localities such as at Chance Creek (near Daisy Lake), where the pines are associated with large numbers of *Ribes bracteosum* and others. Rust apparently became established at Daisy Lake in 1913. On the Pacific Great Eastern Railway about 20 miles northwest of mile 72 on the Tenquilla River there is a centre of infection on *Pinus albicaulis*.

GENERAL.—It is about thirteen years now since blister rust first attracted the attention of this Division and, during that time, its life history, distribution, method and rate of spread, degree of susceptibility of various hosts, potentialities for damage, and methods of control have become fairly well known. Blister rust is a disease which, while originally foreign to this country, has now become so firmly established that it is here to stay, and, as a consequence, it will always be a factor to reckon with as far as the culture of white pines is concerned. It is not spectacular, except in extreme cases, but it is insidious and, therefore, the more dangerous, since the seriousness of the situation is not apparent until much damage has been done. It may be considered as something which will gather momentum as time passes, if it remains unchecked.

Fortunately, blister rust is one of the few important diseases of trees which can be effectively controlled in a practical manner. The precise method of control has been described on many previous occasions, and it is not necessary to go into details here. With such complete knowledge as we now possess

in regard to blister rust, and especially in regard to its control, it seems that the matter now becomes one to be dealt with by those who own the white pine. That is to say, it is not a function of this Department to apply control measures in connection with this or any other disease, excepting for demonstration purposes. Our principal function is to study diseases in all their various aspects, and to point out the best methods of avoiding or controlling such diseases.

In this country the ownership of white pine is vested principally in the various provinces. Apart from this there is a small amount owned privately. The problem of blister rust, then, becomes essentially a matter of forest protection, equally as much so as fire; and as such should be dealt with by the various forest services concerned. If white pine were not one of our most valuable forest trees it would not be worth while to protect it at any considerable expenditure, but under the circumstances it cannot be doubted that, in certain districts, eradication measures should be applied at once. In a circular letter written last year the several interested provinces were advised of our attitude in this matter. To put it briefly we are primarily interested in the research phase of the problem, and not directly in the application of the results of such search, which is without a doubt the duty of the owner of white pine stands.

For the purpose of assisting those interested to become familiar with the appearance of rust in all its stages, and to make known the method of control, the Division has issued an illustrated folder which briefly describes the salient features of this disease.*

A good deal of time has been spent this year in incorporating the results of the field studies, carried on in Quebec upon the limits of Price Brothers and Company, in connection with decay in balsam fir. The two reports which have been made were combined, and are to be published in the form of a bulletin under the title "Studies in Forest Pathology. 1. Decay in Balsam Fir."

CULTURAL STUDIES OF WOOD-DESTROYING FUNGI

"DOTE" DISEASE OF SITKA SPRUCE (*Picea sitchensis* Carr)

Sitka spruce, aeroplane spruce, or silver spruce, as it is commonly called in England, is found only along the Pacific coast of North America from Alaska to Oregon. It grows only at low elevations and in moist situations close to the coast so that the amount suitable for use in aeroplane construction is very limited. It sprang into importance when this wood with its combination of strength, flexibility, softness, light weight, and evenness of grain was found so useful in the structure of aircraft.

Since 1918 the demand for aeroplane spruce has been less urgent, and a large part of the purchases have been made on the ordinary commercial grade of "clear and better rough green spruce," although more recently spruce has been selected on an aeroplane grade as specified by the British Air Ministry. As a result, many complaints have been made of the quality of the aeroplane spruce which is obtained in England. It has been stated that so much spruce had to be culled, due to a defect known as "dote", that eventually this wood became as expensive as Spanish mahogany.

As was mentioned in last year's report, an investigation was undertaken to determine whether or not "dote" is present in aeroplane spruce stock before it is shipped to England. Thanks to the kindness of mill operators in British Columbia, specimens of defective spruce were obtained from aeroplane spruce "rejects", from seasoned stock, and from freshly cut green timber. Type specimens of "dote" were received also from the Air Board in England through the kindness of Dr. E. J. Butler, Director of the Imperial Bureau of Mycology.

* Circular No. 48, New Series.

The investigation has been confined to two defects of aeroplane spruce, the one known as "white dote" or "compression shake", the other as "dote". So far no work has been done on the various moulds and stains which develop on timber in storage and during transit.

(A) "White Dote" or "Compression Shake"

A comparison of specimens has shown that the defects of aeroplane spruce, known as "white dote" in British Columbia and as "compression shake" in England, are one and the same thing. Spruce of this type looks normal in colour but is very brittle or "brash". It lacks strength and breaks across abruptly without splintering. No fungus has been obtained in culture from the few specimens of this defect which have been available. Microscopic sections show the presence of very fine fungous hyphae occasionally, but the defect is in all probability a physiological one due, perhaps, to unfavourable growth conditions or strains to which the tree was subjected before or after felling.

Pulling up the fibres to test the strength of the wood is part of the routine inspection of aeroplane spruce, but, since reports indicate that a great deal of spruce showing "white dote" or "compression shake" has been sent to England, still more stress could be laid on fibre strength tests. In this way, perhaps, more spruce suffering from this defect could be culled before shipment.

(B) "Dote"

A study of a number of pieces of Sitka spruce sent from England as typical specimens of this defect has shown that "dote" is a general term used to cover a number of rots caused by various wood-destroying fungi. All of the specimens of defective aeroplane spruce received from England were so badly rotted and discoloured that they would have to be discarded at any mill. They showed three types of decay:—

1. Wood in which certain areas were more or less uniformly discoloured. The infected area is darker than normal, and in advanced stages the wood is dark brown in colour and easily powdered between the fingers. Some specimens of this type have a very strong odour of anise seed or bitter almonds.

2. Wood in which there are "elongated pipes of decay" with areas of apparently sound wood between. The decayed wood is reddish brown and easily crumbled.

3. Wood in which minute pockets of rot occur here and there. Their presence is indicated by small areas of discoloration in which the wood is uniformly a darker brown. In later stages checks occur and the wood in the pockets is brittle and easily powdered. Specimens have been collected in which these pockets were twelve inches and more in length, separated by eighteen inches of apparently sound wood. In such cases the rotted wood is dark brown, much checked, and easily powdered. This rotted wood frequently drops out of the centre of the pocket leaving large holes edged with rot which passes abruptly into apparently sound wood. Although the wood between the pockets looks normal, cultures have proved that the fungus is frequently present throughout.

From the specimens of Sitka spruce collected in British Columbia a number of fungi were isolated including *Fomes pinicola*, *Polyporus sulphureus*, *Trametes Pini*, a species of *Oedocephalum*, etc., but since these have not been found, so far, in specimens of "dote" sent from England, they need only be mentioned here.

Cultures made from the specimens of diseased wood from England showed that not one but several fungi were responsible for the types of decay known as "dote". Of these fungi three may be mentioned particularly.

1. Perhaps the commonest is *Polyporus Schweinitzii*, the fungus which causes the rot commonly known as "conk-rot". The large, annual fruit-bodies of this fungus consist of a short stalk and a fleshy top; they range in colour from yellow to brown; and the under, pored surface is frequently a dirty green. Cultures of this fungus show the same wide variation in colour as the fruit-bodies do. Cultures which varied somewhat from the type, were isolated from specimens of spruce received from England, and from others collected on the Pacific coast. These cultures grew more slowly, produced a scantier, more delicate mycelium, did not exhibit the same depth of colour, and were characterized by a bitter almond odour which was particularly noticeable on malt agar cultures. Although these cultures remain distinct even in spruce wood-block cultures they have been considered as variations of *P. Schweinitzii*. This fungus was isolated from rotted wood of type 1.

2. From the pocket rot, type 3, whether the pockets were one-half inch or twelve inches in length, an unidentified fungus was obtained. In culture a white downy mycelium is produced which later becomes felted, and numerous large, more or less globular masses of velvety mycelium develop on the surface of the culture. These balls vary in colour from pale yellow to light and deep buff. Microscopically the mycelium is seen to consist of hyaline hyphae which branch frequently and bear numerous clamp-connections. No chlamydospores were noted, but peculiar swellings occur on some hyphae, particularly in prune agar cultures. This fungus is readily recognized but, so far, has not been identified.

3. From wood showing elongated "pipes" of decay, type 2, a fungus was isolated with a delicate, downy, white mycelium, which becomes loosely matted. The mycelium tends to grow around the sides of the tube and to become more dense at the tip of the culture, where a velvety surface results. The mycelium remains pure white except where the plug of velvety mycelium becomes tinted with pale buff. This fungus is recognized by the peculiar foliose, fruiting structures, with hyaline spores, which are produced both on agar and on spruce wood-block cultures. The mycelium is composed of very broad hyaline hyphae with very many large and conspicuous clamp-connections, and produces an abundance of hyaline chlamydospores. This fungus too, is unidentified but readily recognized.

The interesting point about these cultures is that they were obtained from specimens of "dote" sent to us from England. *But in every case, so far, identical cultures have been obtained from specimens of freshly sawn Sitka spruce in British Columbia.* In other words, these fungi may all grow in standing living trees or freshly felled logs of Sitka spruce. It is probable, therefore, that they were present in the Sitka spruce timber before it was shipped from the Pacific coast to England, and that the "dote" was due to their development rather than to fungous infection after shipment.

There is a possible way in which some diseased spruce might be shipped to England as aeroplane stock. It has been shown that the hyphae of wood-destroying fungi are frequently present in the wood beyond the last trace of discoloration. (E. E. Hubert. *The Diagnosis of Decay in Wood*. Jour. Agr. Res. XXIX, 11, 1924.) Then, if care were not taken to discard some of the apparently sound wood beyond the last trace of discoloration, the fungus threads might be present in wood which looked normal and was still strong enough to pass the fibre strength tests. The activities of the fungi would be curtailed when, during seasoning, the amount of moisture present in the wood was decreased beyond that required for fungous growth. But Hubert has also shown (E. E. Hubert. *Effect of Kiln Drying, Steaming, and Air Seasoning on certain Fungi in Wood*, U. S. Dept. of Agr., Bul. 1262, 1924), that such fungi may revive and resume their destructive work when favourable conditions of temperature and

moisture are restored. When aeroplane spruce is close piled in damp holds of ships and then sent via the Panama Canal to England the conditions of moisture and temperature would be most favourable for fungous growth. This fact, alone, however, would not account for the amount of defective spruce which has been bought in England as *aeroplane* spruce, and probably the old practice of purchasing on the ordinary commercial grade of "clear and better rough green spruce" has been responsible for much of the trouble.

Kiln drying in properly constructed, properly regulated kilns will destroy hyphae of wood-destroying fungi and also considerably reduce the time required for seasoning, and if kiln-dried stock filled the requirements of the Air Board the amount of storage space required would be reduced, and the danger from development of moulds and sap strain during storage lessened, and any incipient rot would be checked.

Transporting such carefully seasoned and carefully selected stock as aeroplane spruce in holds of ships seems a precarious practice. During the war, owing no doubt to the urgent need, and also to the curtailment of tonnage, aeroplane spruce was sent by rail to the Atlantic sea board and then by boat to England. Recently several shipments have been made in the same way and a report on them from England states that "they arrived in such good condition that 95 and 100 per cent, respectively, were fully acceptable. This more than compensated for the extra cost of carriage." This, then, would seem to be the logical method of transporting such valuable material.

CULTURES OF WOOD-DESTROYING FUNGI

Last year a list was given of the cultures of wood-destroying and wood-inhabiting fungi included in the mycological collection at Ottawa. During this year the collection has almost doubled in size and, at present, about sixty species of these fungi are represented. The Division is indebted to Dr. Wollenweber, of the Biologische Reichsanstalt, Berlin, Germany, Dr. Fritz of the Forest Products Laboratory, Montreal, and Dr. Richards of the Forest Products Laboratory, Madison, for their kindness in supplying us with cultures. A list of the cultures in the collection is appended:—

Armillaria mellea (Vahl.) Fr.
Calonectria diploa
Collybia velutipes Curt.
Coniophora cerebella (Pers.) Schröt.
Coprinus micaceus (Bull.) Fr.
Daedalea confragosa (Bolt.) Fr.
Daedalea quercina (L.) Fr.
Favolus canadensis Klotzsch.
Fomes annosus (Fr.) Cooke.
Fomes applanatus (Pers.) Wallr.
Fomes conchatus (Pers.) Gill.
Fomes connatus (Weinm.) Gill.
Fomes fraxinophilus (Peck.) Sacc.
Fomes fomentarius (L.) Gill.
Fomes igniarius (Fr.) Gill.
Fomes officinalis (Vill.) Peck.
Fomes pinicola (Sw.) Cooke.
Fomes roseus (Fr.) Cooke.
Lentinus lepideus Fr.
Lenzites betulina (L.) Fr.
Lenzites saepiaria Fr.
Nectria auranticola B. et Br.
Nectria coccinea Fr.
Nectria coccinea Fr. var. *sanguinella*
Nectria rubicarpa Cooke.
Pholiota adiposa Fr.
Pholiota lucifera Lasch.
Pleurotus ostreatus (Jacq.) Quél.

Pleurotus ulmarius (Bull.) Quél.
Polyporus abietinus (Dicks.) Fr.
Polyporus anceps Peck.
Polyporus balsameus Peck.
Polyporus Berkeleyi Fr.
Polyporus betulinus (Bull.) Fr.
Polyporus borealis Fr.
Polyporus chioneus Fr.
Polyporus cinnabarinus (Jacq.) Fr.
Polyporus frondosus (Dicks.) Fr.
Polyporus fumosus (Pers.) Fr.
Polyporus hirsutus (Wulf.) Fr.
Polyporus pargamenus Fr.
Polyporus Schweinitzii Fr.
Polyporus squamosus (Huds.) Fr.
Polyporus sulphureus (Bull.) Fr.
Polyporus Tsugae (Murr.) Over.
Polyporus versicolor Fr.
Poria incrassata (B. et C.) Burt.
Poria subacida Peck.
Schizophyllum commune Fr.
Stereum fasciatum Schw.
Stereum purpureum Pers.
Stereum sanguinolentum (Alb. et Schw.) Fr.
Trametes carnea Wettst.
Trametes Pini (Thore) Fr.
Verticillium albo-atrum Reinke et Berth.
Xylaria polymorpha (P.) Grev.

Sporophores, or pored surfaces, have been obtained in stock cultures of the following species: *Coprinus micaceus*, *Pholiota adiposa*, *Schizophyllum commune*, *Fomes applanatus*, *F. pinicola*, *F. roseus*, *Polyporus anceps*, *P. betulinus*, *P. frondosus*, and *P. hirsutus*. Cultures were made on malt extract, prune, or potato dextrose agars. Abortive sporophores of *Polyporus squamosus* developed in a potato dextrose agar culture. They resembled closely those described and figured by Dr. Buller in his first volume of "Researches on Fungi", pp. 57-58.

The culture of *Coprinus micaceus* from which sporophores were obtained had been kept in stock culture for two years and a half but had remained sterile. Eventually subcultures were made on potato dextrose agar and kept in an incubator at 25° C. A sporophore with mica-like scales, and normal in size, shape, and colour, developed and shed spores, three weeks after inoculation had been made. A repetition of the experiment has given equally satisfactory results.

Fomes pinicola (SW.) COOKE

The studies of the sexuality of *Fomes pinicola* have been continued.

Monosporous mycelia from different fruit-bodies have been isolated and paired. The results show, beyond doubt, that the strains of this species which have been tested are heterothallic and bisexual.

Through the kindness of the Imperial Bureau of Mycology a culture and a specimen of *Fomes pinicola* var. *marginatus* was received from M. Jean Dufrenoy, France. Monosporous mycelia were isolated from it and paired, and, later, paired with those obtained from sporophores collected in Canada. Clamp-connections were formed in every case where monosporous mycelia from the French strain, if we may call it so, were paired with monosporous mycelia from any Canadian strain. These results show experimentally, according to Vandendries, that the European and Canadian forms of *F. pinicola* are identical, for he states, "Si les haplontes de deux carpophores sauvages sont toujours et indéfiniment fertiles entre eux, ces deux carpophores appartiennent à une même espèce".*

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, CHARLOTTETOWN, P.E.I.

(R. R. Hurst, Officer in Charge)

In submitting the report of the field laboratory, Charlottetown, for the past year, it is fitting to draw attention to the excellent facilities which are being afforded by the provision of extra space and equipment. The completed extension of the laboratory will include, in addition to the original building, a basement, and two ground-floor rooms. The disorganization caused by this work made it impossible to perform laboratory activities and greatly retarded experimental efforts. Notwithstanding this, it is gratifying to know that encouraging results have been obtained.

The increasing importance of the seed potato industry was marked by an expansion in potato disease investigations. This phase of the work continues of first importance. Government seed certification in Prince Edward Island has continued to be directed from this office by Mr. S. G. Peppin, Senior Plant Disease Investigator.

In addition to plant pathological investigations bacteriological analyses of well-water from creameries as well as periodic chemical analyses of the city water supply have afforded further public service.

The usual plant disease survey has been carried on.

* Vandendries, R. Nouvelles Recherches sur la Sexualité des Basidiomycètes. Bull. Soc. Roy. Bot. Belg. T. XVI, f. 1, 1923.

EELWORM DISEASE OF ALFALFA

Following the reports that a serious disease has prevented the successful culture of alfalfa in Prince Edward Island a project was initiated designed to discover the cause. Fields were examined in which the disease had been reported previous to 1926. In two cases plants were collected which suggested the presence of a very active parasite but nothing of an epidemic nature was discovered. The crops in question, however, showed much evidence of having had serious injury in past years. It is noteworthy also that fields have been rendered useless in later years. Thin spots were noticeable and in a few fields plants were unthrifty and dwarfed.

In late May the above mentioned diseased plants were found in a wilted condition. Stem-bases and young growths were swollen. Infected parts were brownish and easily detached. A rot was also apparent in the crowns of diseased plants.

Microscopic observations revealed many round worms or Nematodes about one millimeter in length. These were found only in the aerial portions of the plants.

While it is possible that the destruction of alfalfa in the past might be attributed to Nematode attack the theory is disregarded for want of conclusive evidence. It will be necessary to keep alfalfa fields under observation for a reappearance of the attack, and isolate the responsible organism. In the meantime seed has been saved from plants which have survived attack. This will be preserved by growing in plots with a view to studying the reaction to any pathogen which may be found responsible for the disease.

CEREAL RUST INVESTIGATION

In direct contrast with the previous season, stem rust of wheat proved a serious factor in 1926. The standard wheat varieties grown in the province received serious injury, thus discouraging a persistent effort to popularize the production of seed wheat. It was a striking feature that while stem rust appeared commonly on wild grasses early in July, wheat was practically free until late August, and by September 8 the attack had developed epidemic proportions. As a consequence of this it will be difficult, if not impossible, to obtain a good grade of wheat with a high germination test.

Two physiologic forms have been determined to date, namely, XVIII and XIX. Particular interest has been aroused over the appearance of this last form which attacks Marquis but slightly, and the occurrence of which was reported in Canada but once previously. Hard white and red wheats were badly rusted. Of the Durums, Kubanka, Arnautka, and Mindum showed twenty, five, and one per cent infection respectively.

Under the direction of Dr. D. L. Bailey, wheat and oat rust nurseries were continued at the Charlottetown laboratory, and rod-rows were seeded and kept under observation throughout the growing season. A rust survey was made at Charlottetown, Kentville, and Fredericton. These notes, along with rust cultures from each place, were sent to Dr. Newton at the Rust Research Laboratory, Winnipeg, and will be included in the general report on cereal rust investigation.

Spore-trapping was begun on June 1. Urediniospores were trapped July 15, at which time heavy infection of *Puccinia graminis* showed on *Agropyron repens*. The marked scarcity of trapped spores up to September 1, when counts were greatest, indicates that Prince Edward Island is not affected by wind-borne spores.

This year's Barberry survey revealed many bushes in the vicinity of Charlottetown. One large hedge showed vigorous aecia on July 15. Several bushes of *Berberis vulgaris* were found near the Experimental Farm, upon which pycnia

appeared July 1. Aecia were first observed July 12. By July 15 heavy infection was general. No doubt this liberation of inoculum accounted for primary infection and, later, for the serious epidemic.

The presence of infected Barberry and two physiologic strains of rust, one of which is uncommon, creates a promising field for investigation. It is intended that rust cultures from Barberry be examined for strain determination.

The host range of stem rust has been observed as follows:—

Hordeum jubatum.
Agropyron repens.
Agrostis alba.
Triticum vulgare.

Phleum pratense.
Avena sativa.
Hordeum vulgare.

Scarcity of material prevented a continuation of studies upon the viability of over-wintered spores. Uredinia from *Hordeum jubatum* showed no viability in April.

PREVENTION OF BLACK KNOT OF PLUMS

This project, undertaken in 1925, had as its object the destruction and prevention of Black Knot in the plum orchard in connection with the Experimental Farm, Charlottetown, where pronounced increase of this disease threatened to destroy the majority of trees.

In April, 1925, all knots had been removed and burned. By July new knots were abundant but were left to develop. It was evident that removal of knots in April was useless. In March, 1926, previous to spore activities, all knots were carefully removed and destroyed. On this occasion whole limbs were removed if knots were large or numerous. As a further precaution all wild plums in the vicinity were treated similarly. This work was supplemented by three thorough spray applications using lime sulphur of the ordinary strength recommended for orchard spraying. On August 15 three knots which had been developed for some time were removed. No others were observed up till November 1.

From these combined efforts the results encourage hopes that this orchard, if given similar treatment in the future, will survive.

WHITE PINE BLISTER RUST

For some years past *Cronartium ribicola* F. de. Wal. has been reported affecting black and red currants and gooseberries in Prince Edward Island. Uredinia and telia have since been found on *Ribes lacustre* and *Ribes prostratum*. Until 1926, however, there was no official record of infection of White Pine. Preliminary observations in 1925 showed that many young pines were dead or dying, and older trees showed evidence of having received serious injury.

Species of wild and cultivated *Ribes* were common in localities where White Pines grew. On June 14, 1926, heavy infection was found on a clump of *Pinus Strobus* at the Experimental Farm, Charlottetown.

Following this discovery a survey was made of districts in which White Pines were common. On June 23, 75 per cent of the pines in Lot 48 showed heavy infection. Many young trees were dead and large trees were dying. Swellings on limbs, many dead leaf-fascicles, and injured short shoots added to the evidence that blister rust had been active for some time.

The characteristic, spindle-like swellings have been observed for several years. Young branches on which these were noted have died. It has been suggested that the organism remained active as a parasite within the host tissue, causing death of the branch without sporulating.

One is inclined to discredit the possibility of reduction in yield of currants and gooseberries when leaf infection occurs after the fruit has formed. However, the resulting leaf injury may have a direct bearing upon the fact that winter injury is responsible for the death of many bushes each year.

The abundance of wild *Ribes* makes eradication impracticable as a feature in the control of White Pine Blister Rust infection.

On the basis of these observations it seems safe to conclude that the excellent plantations of five-needle pines on Prince Edward Island are doomed.

HOLLYHOCK RUST CONTROL

Hollyhocks play an important part in perennial flower beds in Prince Edward Island. In recent years rust has been such a serious factor that many floriculturists have discarded this beautiful flower. Many varieties are being tested at the Experimental Farm, but the work is limited by the ravages of the rust. In 1925 several plants were killed by the severity of attack. Repeated inquiries regarding control methods prompted an investigation to prove or disprove the value of recommended fungicides and arrive at a suitable control measure.

Two fungicides were used, namely liquid bordeaux (4-4-40) and a solution of potassium permanganate in the proportion of two tablespoonfuls of the saturated solution to one quart of water. A sprayer with good pressure was employed and spray was thoroughly applied to both leaf surfaces and stems. Full row checks were used for both treatments. Spraying operations were begun on May 22 when all varieties averaged 6 inches in height. Applications were made every five to seven days thereafter until August 7 when all varieties were so heavily rusted it was useless to proceed.

Rust pustules were first observed on treated plants June 25. By June 30 primary infection was general. On August 6 rust appeared on checks. Results were, therefore, of a strikingly negative nature. Allowing for reasonable experimental error it is apparent that under the conditions influencing this work, and on a basis of one season's trial, control of this rust is not to be expected from the use of either of these fungicides applied at the above recommended strengths.

It appears that infection is confined chiefly to the lower surfaces. The protection afforded by glandular hairs may prevent spray particles reaching the leaf surface, thus limiting fungicidal effects. No spores germinated in hanging drop suspensions of bordeaux and potassium permanganate of the strengths used. Spores were placed on leaves immediately after receiving applications of bordeaux and potassium permanganate. The leaves were sprayed with distilled water and placed in moist chambers. No germination resulted. On the other hand spores on unsprayed leaves germinated freely in distilled water.

One would conclude, therefore, that control is possible from these fungicides, if not counter-influenced by certain factors, such as the protection afforded by plant hairs, deterioration of chemicals used, time and method of making applications, strength of solutions, etc.

It is a common practice to leave plants on the ground over winter or remove old tops and throw them to one side to decay. Germination tests were performed with a view to investigating the possibility of viable spores originating in this material and initiating primary infection.

Five per cent germination was observed on May 13. Sporidia did not develop. Tap-water suspensions only were used. No observations were made with mycelium from the same source. Inoculation tests were made on June 1 with over-wintered sori. Out of twenty attempts to infect apparently healthy

plants one sorus resulted. While this infection preceded primary infection by twenty-five days, it carried no significance, as the experiment was performed in the absence of control and greenhouse facilities.

Due importance must be attached to the fact that even a small percentage of viable spores has been found late in May. This points to the wisdom of burning all hollyhock tops at the end of the growing season.

It is intended that, in future tests, colloidal dusts will be employed as well as liquid sprays.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, KENTVILLE, N.S.

(J. Fred Hockey, Plant Pathologist, Officer in Charge)

The winter of 1925-26 was one of heavy snowfall. A total fall of approximately 13 feet was recorded at Kentville. The snow remained on the ground late, and many orchards in the province contained snowdrifts early in May. Trees, generally, came through the winter in good condition although some, which were exposed to heavy west winds, suffered a die-back of twigs. Such trees made a good recovery during the summer.

The season of 1925 witnessed a very severe infestation of apple scab. The trees in many orchards suffered heavy defoliation. The results of this were felt to a considerable extent during 1926, as the trees did not have the vitality to set a heavy crop of fruit. Blossoms were very plentiful, but only a small percentage of the pollen of some varieties matured. Generally speaking, orchards which had received good protection in 1925 and which were in their bearing year in 1926 set good crops. The crop as a whole, throughout the valley, was light, but of good quality.

Spraying operations were carried on with greater care than heretofore by the majority of orchardists, and with better results. The season was favourable to scab development, and the unsprayed trees of susceptible varieties invariably showed over ninety per cent scabby fruit. A large proportion of such infection occurred late in the season.

In order to avoid duplication of efforts in orchard work, arrangements have been made with Mr. A. Kelsall, Officer in charge of Insecticide Investigations, Dominion Entomological Laboratory, Annapolis Royal, N.S., to co-operate in commercial orchard experimental spray and dust investigations. Mutual assistance is given as far as possible in the various operations and recording of seasonal and harvesting data. This arrangement gives the laboratory staff at Kentville opportunities of taking observations at any time, as well as of having special applications or treatments made on a commercial scale.

The Kentville Laboratory is now responsible for the moisture content determination of samples of evaporated apples, etc., as taken by the inspectors of the Health of Animals Branch, Department of Agriculture, Ottawa. This has been done at the request of local evaporators in order to make the determinations available to them sooner than heretofore.

APPLE SCAB

The study of the perithecial development and spore discharge of *Venturia inaequalis* (Cke.) Wint. was continued in 1926 along similar lines to the work done in 1925. (See report of Dom. Bot. pp. 29-32, 1926). On account of publicity given to this work there was a demand from growers for reports on the stage of development of the fungus in specimens sent to the laboratory. These were received from various parts of the valley, and gave an opportunity for rough comparisons of the relative earliness of spore development.

Collections of old apple leaves were made periodically at Kentville, from April 1. Collections up to May 1 showed nothing but perithecial development. Ascii formation commenced about this time and, by May 10, the first signs of spore formation became apparent. One inch and two-tenths of rain fell on May 11 and 12. Collections on the following day revealed ascospores forming rapidly. By May 15 a few maturing spores were formed and the first discharge took place May 17-18. From this time to July 15 there were intermittent discharges. There was a fairly heavy discharge during June 6, 7, and 8, at the time the buds were in the pink stage and some of the earlier varieties in bloom. During the period of June 14-17 inclusive, the heaviest discharge of ascospores was recorded. At this time many varieties were in full bloom and some early ones dropping their petals. After June 29, ascospore discharge was very slight at any time, and it is not believed that the discharges after that date, and up to the last one recorded July 15, caused any appreciable infection in the orchard.

It should be noted that the seasonal development of the apple was about seven days later than in 1925, whereas the fungus development was only two days later in time of initial maturity of spores, and discharge lasted over a period of the same length as in 1925.

The first infections were found on June 4—one day later than in 1925.

	1925	1926
First ascospore discharge.....	May 15	May 17-18
First conidia infection.....	June 3	June 4
Heaviest discharge.....	May 31—June 2	May 23-25
	June 10-11	June 6-8
	June 15-18	June 14-17
	July 13	July 15
Last discharge.....	June 2-10	June 10-18
Full bloom.....	2.37 in.	3.75 in.
Rainfall May.....	4.97 in.	3.33 in.
Rainfall June.....	3.34 in.	2.98 in.
Rainfall July.....	204.9 hrs.	171.70 hrs.
Sunshine May.....	199.55 hrs.	243.25 hrs.
Sunshine June.....	234.75 hrs.	217.20 hrs.
Sunshine July.....		

In view of the similarity of these records of the months of May and June of 1925 and 1926, it is not surprising that unsprayed trees of susceptible varieties yielded practically 100 per cent scabby fruit this year as in 1925. While the total crop of the province was slightly less than 1925, the fruit on the average was much cleaner, and, due to a favourable season of weather at time of maturing, it was of good quality.

Through the kind co-operation of Mr. F. C. Gilliatt, Entomological Laboratory, Annapolis Royal, records were taken of the early seasonal development of the fungus in that section. The first ascospore ejection took place on May 25, and was very light. At this time the blossom bud leaves were about the size of a ten cent piece. No further discharge was recorded until June 2, when a moderate ejection took place. The Gravenstein blossoms were then showing pink. There was a total rainfall in May of 2.56 inches at Annapolis, compared to 3.75 inches at Kentville. During the period up to June 2, there were thirteen days when spore ejection was observed at Kentville, compared with two days of similar records at Annapolis Royal. This would indicate a relationship between rainfall and spore discharge intensity, but further observations will be necessary over a period of years before definite conclusions can be drawn.

In conducting studies on the seasonal development of the apple scab fungus in Nova Scotia, it was thought that it might be to the advantage of fruit-growers in other parts of the Maritime Provinces, if records on spore discharge were taken in the three provinces. Accordingly, through the hearty co-operation

of the staffs of the Plant Pathology Laboratories at Fredericton, N.B., and Charlottetown, P.E.I., a sub-project was initiated to procure comparable records from these provinces. It is hoped that such records may be obtained for two or three successive years, after which it will be possible to deduce more reliable information.

There is a general similarity in the results obtained at Fredericton, Charlottetown, and Kentville during 1926. Heavy discharges were experienced at all points before bloom and again during full bloom or immediately following.

It is quite evident from these records that, as a general rule, two pre-blossom applications of spray should be used in orchards in the Maritime Provinces, if sufficient protection is to be obtained from early spore discharges. There are seasons when one pre-blossom application gives sufficient protection. There are others when three sprays are necessitated through the prolonged slow growth of the tree. But an average of two sprays before bloom will invariably give good economic control of apple scab in these provinces, if followed by two after blossom applications of fungicide.

The pre-blossom sprays protect the foliage; the two after-blossom protect the fruit. But the four sprays, at least, are essential for all-round control of fruit spotting, as summer infections on the fruit come almost entirely from spots on the foliage and fruit which started during the spray season.

Effect of chemicals applied to old leaves on the development of V. inaequalis

From time to time investigators in different parts of the world have reported that spraying the ground at the time of regular applications decreases the incidence of apple scab on the fruit and foliage. Others have reported negative results. From studies in connection with the development of the fungus in the old leaves it became evident that any such treatment of fallen leaves, to be effective, must be either one, that disintegrates the perithecia or leaf tissue, or one, that penetrates the leaf and fungus tissue to inhibit spore development.

As our regular spray materials are prepared with the object of avoiding injury to leaf tissue, their penetrative properties are practically nil. However, from experience in burning foliage with Bordeaux sprays, it became evident that copper sulphate alone would penetrate leaf tissue quite readily. Caustic soda is frequently used as a dormant spray for freeing the bark of trees from lichens and has a cellulose-destroying property.

To test out the two hypotheses, preliminary tests were undertaken with copper sulphate, caustic soda, carbon bisulphide, and water as a check. Ten per cent solutions or emulsions of these chemicals were used. Apple leaves showing a fairly uniform stage of perithecial development were collected and subsequently divided into four lots and treated by spraying with the respective solutions or emulsion. Microscope slides coated with fixative were placed over representative leaves and daily observations taken on ascospore discharge.

The copper sulphate series gave a slight spore discharge the day following treatment, and no subsequent discharge.

The caustic soda series gave no discharge after treatment.

The carbon bisulphide series gave intermittent discharges throughout the test, but of about one-quarter the intensity of the check series.

The check series, sprayed with water, discharged spores freely throughout the test.

At the end of 12 days, leaves from each series were examined to find the condition of the fungus. The copper sulphate and caustic soda series showed no further development of the fungus from that at the commencement of the test. About 25 per cent of the carbon bisulphide series showed well developed asci and spores. The water series were all well developed. In inhibiting the development of the fungus, the caustic soda caused a disintegration of leaf and fungus tissue.

Subsequent laboratory tests with one per cent solutions of copper sulphate and caustic soda yielded similar results.

In order to make a preliminary test of the commercial possibilities of this method of apple scab control, arrangements were made with Mr. A. Kelsall, Entomological Laboratory, Annapolis Royal, to treat an experimental orchard. The orchard was divided into three large sections. On one section the leaves on the ground were sprayed with 1 per cent caustic soda solution. This material spread and adhered readily. Another section was similarly treated with a 2 per cent copper sulphate solution. It was found that this solution did not spread readily, and a greater quantity was necessary to cover the leaves. The third section—a strip between the two treated areas—was left untreated. Approximately 180 gallons per acre were used on the caustic soda plot, and 200 gallons per acre on the copper sulphate plot. The treatments were applied one week prior to the bursting of the leaf buds.

Representative leaves from each plot were collected May 27, and examined. The following observations were recorded:—

One per cent NaOH—Some mature spores found. Many leaves showed partial disintegration of fungous and plant tissue.

Two per cent Cu SO_4 —Normal or early spore development and discharge. Possible stimulations of fungous growth. No signs of delayed perithecial formation.

Check—Normal development and discharge apparent.

Three weeks later, an examination of the foliage in the orchard showed that the primary infections from ascospores were heaviest on the check plot, lightest on the copper sulphate plot, and intermediate on the caustic soda plot. The entire orchard received two more applications. As this orchard was divided into several spray plots running at right angles to the ground treatment plots, it was necessary to take records on the individual spray plots and average the results for the three large treated areas. While the counts of fruit infections taken at harvest do not indicate the direct results of control effected by ground treatments, yet they do show the commercial control effected. The season of 1926 was very favourable to late fruit infections from conidia during September. This accounts to some extent for the amount of spot present at harvest.

Summary records of the amount of scab present at harvest give the following results:—

Treatment	Per cent scab.
Copper Sulphate.....	24.44
Caustic Soda.....	31.78
Check, no treatment.....	34.56

The spray check plot was not included in these averages, as, on each of the three plots, the infection was over 99 per cent, due largely to late infections from conidia and, therefore, not as representative of the control of infection from ascospores as the sprayed plots. It was impossible this season to make actual counts of primary infection before secondary conidial infection took place.

These results, however, indicate a certain measure of control from one ground application of copper sulphate, when used in conjunction with regular sprays. It may be added that the percentage spot on the individual spray plots was invariably in favour of the copper sulphate treatments. This plot was on the south side of the orchard. The prevailing winds are from the north west; hence the plot had no advantage from location.

No recommendation can be made from these tests, but they do suggest that ground treatments may be available which can be used in conjunction with spraying to clean up uncared for orchards. Further work of more extensive nature is being planned for 1927 in co-operation with the Entomological Laboratory, Annapolis Royal.

LATE SUMMER DUSTS FOR THE CONTROL OF SCAB AND SOOTY BLOTCH ON APPLES

There are several varieties of apples grown in Nova Scotia that are very susceptible to scab. Among these is the Wagener, now being grown in increasing quantities. This variety is liable to severe late infections of scab which appear on the fruit about picking time. In very wet autumns this variety is also quite susceptible to sooty blotch.

With the view of ascertaining the possibility of controlling either or both of these diseases, several adjacent rows of Wageners in the main experimental orchard at Kentville were given special applications of sulphur dust as shown in table 1.

TABLE 1

Plot	Last regular treatment	Special
1. R. 14.....	July 2nd, lime sulphur.....	Aug. 3rd.
2. R. 15.....	July 2nd, lime sulphur.....	Aug. 20th.
3. R. 16.....	July 2nd, lime sulphur.....	Sept. 9th.
4. R. 17.....	July 2nd, lime sulphur.....	Adjacent check.
4A. R. 25.....	July 5th, wettable sulphur.....	Comparative check.

The fruit was harvested about October 21 and placed in barrels in the warehouse storage. On November 16, the apples were carefully examined and all scabby fruit separated into one of three classes,—

Those having old spots only.

Those having new spots only.

Those having both old and new spots—doubles.

The old spots were identified as those which appeared to have been caused early in the growth of the apple. New spots were the new infection areas usually very small and with the ruptured cuticle adhering to the borders of the scab spot. A summary of the observations made at the time of this examination of the fruit is given in table 2.

TABLE 2.—LATE DUSTS ON WAGENERS

Plot No.	Number fruit counted	Scab in per cent				Clean
		Old	New	Doubles	Total	
1.....	744	2.7	4.3	1.9	8.9	91.1
2.....	642	0.8	2.3	0.9	4.0	96.0
3.....	702	1.1	4.4	1.0	6.5	93.5
4.....	640	3.9	13.9	6.7	24.5	75.5
4A.....	557	4.3	45.8	19.9	70.0	30.0
4 average.....	598	4.1	29.8	13.3	47.2	52.8

The actual time when the late infections took place was between September 7 and 10. Two or three days of dull wet weather were experienced at this time. An examination of drops of water adhering to the fruit revealed that conidia of *V. inaequalis* were present and germinating. Infections were observed about eighteen days later in the form of small scab spots frequently called "pin head spotting."

From the results given in table 2, it can be seen that any of the three applications gave an economical control of late scab. The application of August 20, appears to have given the best control. It is probable, however, that an application immediately prior to September 7, would have given even better control than that on September 9, as there was plenty of time from September 7 to 9, when weather conditions were favourable to infection.

As no sooty blotch has appeared on the fruit to date, it is not possible to give any indication of the value of these late dusts as control measures for that disease.

The cost of applying the extra dust was approximately three cents per barrel. The value of a late application of dust depends on the condition of the fruit and foliage through the early summer. If the fruit and foliage have been kept fairly free from scab up to midsummer, the chances of late infections of spot are greatly reduced. It was originally planned to use a late application of spray about August 15, but the sprays applied early in July were still prominent on the fruit and a further application would have left too great a residue of spray materials on the fruit and thus reduced their commercial value. Some orchards in which spraying was done as late as August 1, showed considerable unpoisoned spray residue at harvest. The dust was observed only on apples which had apparently received a blast of dust from the proximity to the blower.

It is apparent from this test that an application of sulphur dust about September 1 on susceptible varieties of apples will control late infections of apple scab

CURRENT RUST

(*Cronartium ribicola*, F. deWald.)

Currants are not grown on a commercial scale in this province, but observations have shown that the rust is commonly found on them and, as there is a small patch on the Experimental Station, Kentville, it was considered advisable to try measures of control. The patch locally has not yielded a good crop of fruit for some time. This may be attributed in part to the fact that the bushes for the past two years have become completely defoliated by the end of August and invariably come out in new leaf during September. The forced development of two crops of foliage weakens the bushes and minimizes the possibilities of fruit setting.

The reported success in controlling cereal rust by sulphur dust in the United States and Canada suggested the use of sulphur dust in the control of currant rust.

Accordingly a superfine dusting sulphur was obtained and applications made on various plots in the plantation on May 19, June 2 and 24, and July 9. On June 2, the bushes were commencing to bloom. All applications were made with a hand duster and preferably when there was some moisture on the leaves.

Aecia of the fungus were mature by May 14 on pine trees less than one-quarter mile from the currant plantation.

A summary of the results for one year is given in table 3.

TABLE 3

Number of applications	Per cent rusted leaves	Per cent infection
1.....	100.0	50.0
2.....	82.5	4.22
3.....	66.66	1.41
4.....	26.58	1.24

Of the three varieties—Black Victoria, Boskoop, and Saunders—included in the plantation, Boskoop was the most resistant and Black Victoria the most susceptible.

While no definite conclusions can be drawn from one season's observations, it appears as though thorough applications of sulphur dust will materially reduce the injury from this disease. In place of the early defoliation which has taken place in the past, the bushes retained their first set of leaves throughout the season. The effect, if any, on yield will be most apparent in 1927.

More complete tests of several fungicides are planned for 1927. These results are from one season's work only and are not offered as a general recommendation to growers, but rather to indicate that under conditions existing locally, very promising results may be expected. It is hoped that definite recommendations can be made another season.

CLUB ROOT OF TURNIPS

This project is being carried on jointly between the Laboratories at Fredericton, N.B., and Kentville, N.S. Fifty-four and forty-eight varieties and strains were tested on heavily infested soil at the two stations respectively. Some of these included seed from previously selected stocklings, with the object of obtaining a variety more resistant and higher yielding under local conditions.

At Fredericton there were only two varieties which produced any clean roots. These were a selection of Herning strain made in 1924, and the original Sludsgaard strain. The yields of these two were among the highest in the plots. At Kentville no variety or selection gave clean roots, but the yields per acre were considerably higher than those at Fredericton, and the majority of Bangholm strains gave no severely clubbed roots on plots averaging pH 7.02. Of the fifty-four varieties and strains tested at Fredericton, there was none outstanding in yield or resistance to clubbing. All tests at Fredericton were conducted on soil with a pH range from 6.8 to 7.2, and the differences in yield per acre between the lowest- and the highest yielding plots was 703 pounds.

At Kentville thirty-six of the forty-eight varieties and strains tested were planted on soil with a pH range from 6.6 to 7.4, averaging 7.02. The entire forty-eight varieties were planted in duplicate in plots with a pH range from 6.0—6.4, averaging 6.24, and the twelve varieties not included in the pH 7.02 range were in triplicate in the more acid plots. A comparison of yields at these respective ranges of acidity is shown in table 4.

TABLE 4

	pH 7.02	pH 6.24
Average yield of 24 Bangholm strains.....	17,270	3,553
Average yield of 24 Swedes and Turnips.....	10,458	1,067
Average yield of 36 varieties and strains.....	15,000	2,576
Average yield of 48 varieties and strains.....		2,022

The soil was heavily infested with the club-root organism, and no clean roots obtained. The range of yields in the Bangholm strains on soil of pH 7.02 was 10,250 to 26,000 pounds per acre, compared with a range of 4,000 to 20,000 for the other varieties.

These tests at Kentville indicate the necessity of determining, if possible, the effect of soil acidity on yield independent of the effect of the club-root organism. There appears to be a pronounced influence on yield when soil acidity is associated with the parasite, but whether the soil acidity, without the effect of the parasite, will have a depressing effect on yield remains to be found out. It is known that infection of cabbages by *Plasmodiophora Brassicæ* takes place most readily at pH ranges 6.0 to 6.5. It is, therefore, possible that

resistance of plants to this disease may be partially dependent on the ability of a variety to make a normal growth at ranges of low soil acidity. It is hoped that further investigation will throw more light on this factor.

A number of stecklings from different varieties were planted in 1926 and the seed collected for testing in 1927. A further selection was made of 1926 roots to plant for seed purposes in 1927.

APPLE RUST

A few specimens of rust were found on Gravenstein apples during the late summer, in a fruiting stage. Examination of the fungus established that the rust present on the fruit was the aecial stage of *Gymnosporangium germinale* (Schw.) Kern. This corroborates the statement made in the Annual Report of the Dominion Botanist for 1925, page 38. The rust was not a serious factor this year. Less than one per cent affected fruit was found on any variety examined.

Sclerotinia ON FIELD CROPS

This past season a heavy infection of stem rot of hemp was experienced in experimental plots at the Kentville Station. The rot was caused by a *Sclerotinia* sp. and affected some 40 per cent of the plants in some plots. No difference in the intensity of the disease could be attributed to the different types of fertilizers employed in the various plots. During 1925 the same crop was on different soil, but was also affected. This season carrots were planted on the soil which produced hemp in 1925, but the *Sclerotinia* showed up in storage and caused a complete loss of the stored roots. Sclerotia of the fungus were abundant on the decaying roots, and also a considerable number of secondary rot fungi and bacteria.

The same fungus was also found in a small percentage of sunflowers being grown for ensilage purposes.

Sclerotia were collected from these and other sources and placed in sand in moist chambers. Apothecia developed, and from spore measurements and general description, the fungus appears to be *Sclerotinia sclerotiorum* (Lib.) Massee. As this fungus is known to attack these and various other crops, it would be advisable not to plant hemp, carrots, or sunflowers on soil which has borne any of these crops within the previous two or three years.

Further investigations are being made on this fungus which may yield more definite control recommendations.

APPLE STORAGE INVESTIGATIONS

A considerable amount of time has been spent during the autumn of 1926 on apple storage investigations. Working in co-operation with the National Research Council, the officer in charge has assisted in preliminary investigations in representative local warehouses. An attempt is being made to ascertain the existing conditions in apple storage houses in so far as they affect ventilation and keeping qualities of the fruit in storage. A report on this work will be presented to the National Research Council at the completion of the first season's investigations.

In the apple warehouse at the Experimental Station, Kentville, two storage rooms were built in the basement storage. One of these has a concrete floor in order that lower humidities may be obtained than in the second room which has a dirt floor. Comparative lots of several varieties of apples are being stored in the two rooms. Temperature and humidity records are taken daily, and once

a month a pressure test is made on ten apples from each lot. The pressure tester in use is one improved by Dr. J. F. Magness and manufactured by D. Balleuf, Inc., 621 H. St. Northwest, Washington, D.C. This instrument is exceptionally useful in making comparisons of the keeping qualities of apples in storage. A detailed report on this work will be published at a later date.

EXTENSION WORK

During the past year there has been a request from the fruit-growers for the inauguration of a spray service. The question was taken up with Entomological Laboratory officials at Annapolis, and the N.S. Fruit Growers' Association. It was agreed that the Meteorological Service at Toronto be requested to supply such special weather forecasts as would be most advantageous for farming activities, and that the Entomological and Plant Pathological Laboratories in the province supply such seasonal notes on the appearance and development of insect pests and plant diseases as could be published in press bulletins and would be of value to orchardists in their spraying operations.

Weather forecasts were made available at several points in the Annapolis valley, and warehouse managers took the responsibility of disseminating these forecasts to any grower desiring them. The staffs of the two laboratories mentioned, and a member of the provincial Department of Natural Resources staff from Truro sent to the secretary of the F.G.A.* as often as was deemed advisable such notes on the appearance of insect pests or forecasts of spore discharges of disease-producing fungi as would aid the grower in timing his spray or dust applications. These bulletins appeared in the daily press and did much to encourage timeliness in spraying. It has been felt that such a service can be greatly improved in effectiveness, and plans are now under way for a better organization for 1927.

There is a strong feeling among the local investigators in orchard pest control problems that a service which can supply the growers with such seasonal information on insect or fungous development as they themselves are unable to obtain will be of greater value than a service which supplies complete information on time of application, spray material to use, varieties to spray, etc., for each application. Newly recommended practices, which have proved satisfactory, are quickly adopted by the best growers without such special emphasis as a spray service gives.

Another form of extension work which proved of use to many was examination of a large number of specimens of apple leaves to note the development of perithecia of the apple scab fungus and forecast probable dates of spore discharge. This work entailed a considerable amount of time, but it was felt that any effort which would aid the growers in controlling diseases would be time well spent.

In addition, the officer in charge has addressed several community meetings of fruit growers, on various subjects relating to plant disease control. An address was also presented at the annual meeting of the Nova Scotia Fruit Growers' Association, which appeared in full in the annual report of that organization.

* Fruit Growers' Association.

SEED POTATO IMPROVEMENT IN NOVA SCOTIA

(W. K. McCulloch, District Inspector)

In addition to the work for which the Inspection Service is responsible, seed potato improvement work is carried on from this Laboratory (1) on plots at the Experimental Station and (2) on farms in the country.



PLATE 5.—FIELD OF GREEN MOUNTAIN POTATOES, PRACTICALLY FREE FROM MOSAIC, THE FOUNDATION STOCK OF WHICH ORIGINATED FROM TUBER UNITS IN 1924

The work in the Laboratory plots consists mainly of an endeavour to produce disease-free lines of potatoes of the most popular varieties. In this way, not only is a limited supply of seed made available for those who desire the nucleus of a good seed plot, but a good opportunity is afforded for the study of the symptoms of off-type or diseased plants, and of the reactions of such

plants to the approved methods of control, more especially roguing and isolation. In 1924 a large number of tubers were tested by the eye-index method in the greenhouse, and 9 tubers of the Bliss Triumph variety, 10 of Irish Cobbler, 10 of Garnet Chili, and 10 of Green Mountain were found to show no symptoms of disease. These were planted in the field, the same season, on the tuber unit method. A tuber unit consists of all the sets from one tuber planted consecutively, and separated by 2 feet or more from the next unit. Under this method it is easier to detect a diseased tuber and to rogue out its various parts or hills than if the sets be scattered. The product of a tuber unit is referred to as a tuber line.

At the close of the season 1926, 3 tuber lines of Bliss Triumph variety, 7 of Irish Cobbler, 5 of Garnet Chili, and 4 of Green Mountain were still apparently healthy. That is, out of the original 39 tubers planted in 1924, the direct product of 19 tubers could show a clean bill of health for three seasons. With the exception of the Bliss Triumph variety all units showing disease symptoms were discarded. Bliss Triumph seed being scarce, it was decided to retain the diseased lines and try the effect of isolation and careful roguing—these practices having recently given good results with Garnet Chili and Irish Cobbler varieties, and to a less extent with Green Mountain.

In addition to the above, 584 new tuber units were given a preliminary trial this year. Included among these were strains of Irish Cobbler, Green Mountain, Bliss Triumph, Early Rose, Early Norton, and Dakota Red. Ninety-five were saved for further testing. All lines and units kept for further work were saved in such a way that one tuber can be taken from each hill, composing the unit or line of this year, for indexing purposes in the greenhouse.

The second phase of potato improvement work has consisted in the selection of hills and the establishment of seed plots on the farms of men desirous of such help. Much success has attended this work in regard to the improvement of the Garnet Chili variety. Leaf-roll disease which was formerly a menace is now well under control. Off-type tubers, more especially those running to a point, instead of retaining the square blunt appearance at the seed-end, are very much less in evidence than formerly. Counts made three years ago gave 25 to 30 per cent of the tubers as approaching the ideal shape. This year counts gave an average of 50 per cent.

Considerable success has also been attained by selection and tuber unit work in North Mountain district of Kings County. Here could be seen a two acre field of Green Mountain potatoes which were apparently free from mosaic disease, and which yielded 770 bushels of smooth clean tubers. The foundation stock of this seed was selected in 1923 from a field showing at least 6 per cent mosaic. It was planted in tuber units in 1924, and in a multiplying plot in 1925—showing in that year 1 mosaic plant in 1,600.

On the same farm were fields of Irish Cobbler variety, originating from tuber units selections, which have shown apparent freedom from constitutional diseases for three successive seasons.

Plate 5 shows a field of Green Mountain potatoes, the foundation stock of which came from tuber units in 1924. This field showed less than one-tenth of one per cent of mosaic disease this year, and gave a yield of 385 bushels per acre.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, FREDERICTON, N.B.

(D. J. MacLeod, Officer-in-Charge)

The activities of this laboratory during 1926 were concentrated mainly on problems relating to the potato, a crop of outstanding economic importance in this province, and, therefore, warranting greatest consideration. The adequate laboratory facilities now enjoyed coupled with the fact that no changes were made in the staff during the past two years afforded a larger measure of continuity being maintained in the progress of investigational work than formerly. Each of the major problems occupying the attention of the laboratory is constantly opening up new avenues which require exploration, and results of practical significance are foreshadowed in certain lines of work. In addition to those included in this report, there are certain problems under investigation, results of which are as yet insufficiently determinate to warrant publication, and for that reason are withheld for confirmation another season.

The spring of 1926 was cold, especially during April, and this was followed by a period of considerably increased temperature in May and the early part of June. Subsequent to that, however, and up to October, low temperatures in conjunction with marked humidity prevailed, conditions which enhanced the prevalence of plant diseases. This was particularly evidenced with respect to rust on wheat and oats, which closely approximated epidemic proportions during the latter part of the season. The conditions aforementioned also contributed to a marked manifestation and persistency in the symptoms of constitutional diseases of the potato, rendering their detection readier than has formerly been possible for a number of seasons.

The intention, prompting the distribution last year of the circular letter setting forth the aims, objects, and service offered agriculturists by this laboratory, has borne fruit, as evidenced by the considerable number of plant disease specimens forwarded for identification, and enquiries of divers kinds concerning our endeavours.

OPTIMUM SPACING OF POTATO PLANTS FOR THE PRODUCTION OF CERTIFIED SEED

In 1925 an experiment was incepted for the purpose of determining the best spacing interval for seed potatoes intended for certification, such that the largest possible quantity of tubers from the average crop will conform to the requirements of the established standard.

The results obtained in 1925 which are incorporated in the report of this laboratory for that year, showed in a measure that close—as opposed to wide—planting of potatoes materially improved the quality of the crop through reduction and increase in the average size of large and small tubers respectively, co-incidentally increasing the net yield. The many factors which tend to complicate a problem of this sort, such as weather conditions, soil fertility, etc., render it inadvisable to deduce final recommendations from a single season's results. Therefore, with a view to confirming the former year's results, the experiment was repeated during 1926 in exact accordance with the procedure adopted the previous season.

The results obtained are embodied in tables 5 and 6.

TABLE 5—BEST SPACING FOR PRODUCTION OF CERTIFIED SEED*

Green Mountain

Spacing interval	Yield per row in pounds				Yield per acre in bushels			
	Under 3 oz.	3-12 oz.	Over 12 oz.	Total	Under 3 oz.	3-12 oz.	Over 12 oz.	Total
6 inches.....	34	249	.....	283	51	373.5	.....	424.5
8 ".....	27	204	.....	231	40.5	306	.....	346.5
9 ".....	27	223	.....	250	40.5	334.5	.....	375
10 ".....	24	217	.....	241	36	325.5	.....	361.5
12 ".....	22	202	.....	224	33	303	.....	336
14 ".....	24	182	.....	206	36	273	.....	309

Irish Cobbler

6 inches.....	66	151	.....	217	99	226.5	.....	325.5
8 ".....	46	166	.....	212	69	249	.....	318
9 ".....	46	160	.....	206	69	240	.....	309
10 ".....	46	169	.....	215	69	253.5	.....	322.5
12 ".....	44	164	.....	208	66	246	.....	312
14 ".....	49	158	.....	207	73.5	237	.....	310.5

TABLE 6.—RESULTS OF A SIMILAR EXPERIMENT CONDUCTED AT CHARLOTTETOWN, P.E.I., UNDER THE SUPERVISION OF MR. S. G. PEPPIN

Green Mountain

Spacing interval	Yield per row in pounds				Yield per acre in bushels			
	Under 3 oz.	3-12 oz.	Over 12 oz.	Total	Under 3 oz.	3-12 oz.	Over 12 oz.	Total
6 inches.....	15	134½	27½	177	30	269	55	354
8 ".....	14½	122	19	155½	29	244	38	311
9 ".....	16	112½	23	151	32	225	46	303
10 ".....	13½	115	34	162½	27	230	68	325
12 ".....	6	98	53½	157½	12	196	107	315
14 ".....	8	80	42	130	16	160	84	260

Irish Cobbler

6 inches.....	111	104½	.....	215½	166½	156¾	.....	323½
8 ".....	84	141½	.....	225½	126	212½	.....	338½
9 ".....	79	128½	.....	207½	118½	192¾	.....	311¾
10 ".....	77	155	.....	232	115½	232½	.....	348
12 ".....	62	159½	.....	221½	93	239¾	.....	332½
14 ".....	54½	150½	.....	205	81¾	225¾	.....	307½

These results strongly corroborate those obtained in 1925 and further demonstrate that close planting tends to produce a larger amount of tubers ranging from 3 to 12 ounces than does wide planting, thereby enhancing the eligibility of such tubers for certification. In addition these results further substantiate that the total yield obtained increases correspondingly with a progressive decrease in the spacing interval and vice versa. The marked consistency obtained with respect to the definite correlation between decreased spacing interval and increased yield, amplifying the results obtained in 1925, warrants even a stronger recommendation of the practice of planting all stock intended for certification as close as is consistent with efficient roguing methods.

*The tabulated data represent the average results from duplicated plots.

THE SEASONAL DEVELOPMENT OF APPLE SCAB

Venturia inaequalis (Cke.) Winter

Certain principal stages in the life-history of the apple scab fungus, too well known to warrant description here, which contribute largely to the basis for control programs, are influenced considerably by environmental and seasonal conditions, incidentally necessitating variations in control measures accorded general usage to render the same applicable to localities where different and especial conditions obtain. Therefore, as comparatively little is known concerning the development of the disease and factors influencing it in this province, a project was initiated during 1926 in a preliminary form to determine the time of initial and subsequent ascospore discharges, as well as any correlation existing between the occurrence of these discharges, temperature, and intermittent or continuous successive periods of rainfall occurring during the season. Knowledge of such a correlation would materially assist in forecasting the approximate time of impending, initial, and subsequent ascospore discharges, thereby affording timely information concerning the respective number of fungicidal applications necessary to secure most efficient control of the disease.

The project was conducted in collaboration with and according to the plan adopted at the Kentville laboratory, where an extensive investigation is in progress on the disease as occurring under Nova Scotia conditions. The results obtained at this laboratory will not be elaborated upon in this report, but incorporated in that of the Nova Scotia laboratory, which will embrace an outline of the disease as occurring in the Maritime provinces as a whole.

Owing to the fact that facilities were not afforded to conduct the investigation on a scale embracing several representative localities this season, the work undertaken was confined to a study of conditions obtaining in the Experimental Station orchard at Fredericton.

A brief outline of observations made is as follows: much snow still remaining on the ground during the greater part of the month of April rendered it impossible to gain access to leaves from unsprayed trees, placed in certain representative localities in the orchard, until the 22nd of that month. An examination of leaves collected on this date revealed the presence of minute perithecia of varying dimensions but no differentiation of protoplasm into asci. On May 1 asci were observed, and on May 3 the formation of ascospores was determined. The several spore traps employed, numbering eighteen in all, were set out on this date, and daily records were kept of each until the 10th of August. The first important ascospore discharge occurred on May 25, when leaf development was at the green tip stage. Ejected ascospores were observed, however, previous to this date, but were too limited in number, averaging only one or two to each slide, to consider the same of important significance. It is probable that these spores were discharged from certain prematurely developed perithecia, or may have been reproductive bodies of other fungi morphologically similar to *Venturia inaequalis*, rendering their differentiation from those of the latter quite confusing. Discharges of slightly increased magnitude to the initial, with few exceptions, continued daily until June the 6th, when leaf development was a few days past the pink stage. Subsequent discharges also continued daily, attaining maximums at more or less regular intervals ranging from five to seven days, until the 27th of July, manifesting only one very heavy discharge during the interval between that date and August the 10th. The heaviest discharge occurred on July 13. The first appearance of scab lesions on leaves was recorded on June 18 on unsprayed, and on June 23 on sprayed trees. Consideration of observations recorded revealed a perceptible correlation existing between the occurrence of maximum discharges, precipitation, and temperature under the limiting factor of sunshine. While the results obtained embody certain self-

evident discrepancies, the observations made justify the continuation of the investigation in subsequent seasons, as well as rendering possible a material improvement in the technique which may be employed in the progress of these observations in the future.

SPINDLE-TUBER

Spindle-tuber belongs to the virus group of potato diseases, the cause of which is still unknown. The disease was reported by investigators in the United States and Europe nearly a decade ago, but is of comparatively recent recognition in this province as a limiting factor in potato production. Its insidious nature as heralded by potato experts, particularly in the United States, stimulated considerable interest among investigators in Canada, especially the Seed Potato Inspection Service, with the result that this laboratory, situated in an important potato growing locality, undertook the investigation of the disease as occurring under New Brunswick conditions.

In 1925 a number of tubers from well recognized strains of Green Mountain and Irish Cobbler varieties were inoculated with the virus of spindle tuber by the tuber graft method, utilizing for the purpose tubers which were definitely known to be affected by the disease. The several tubers thus inoculated were planted in soil of average fertility; and a certain number of plants emanating from the same were confined within specially constructed cotton-covered cages which permitted entrance of air and sunlight, while at the same time affording ample protection against insects capable of communicating other virus diseases, the presence of which would interfere materially with the intention and purpose of the experiment. A corresponding number of inoculated plants were not provided with cages, to afford observations under ordinary field conditions. Healthy tubers* from the same strains were planted under both field and caged conditions as checks.

During the growing season and at harvesting time careful observations were made to determine the characteristic symptoms manifested by the vines and tubers, and also the yields from both diseased and healthy plants were compared to estimate the amount of reduction produced by the disease. In addition efforts were made to ascertain the various artificial and natural agencies by which transmission of the disease can be effected. In 1926 the experiment was conducted in accordance with the plan followed in 1925, only on a larger and more comprehensive scale, using in all cases tubers from plants grown under caged conditions the previous year. This procedure afforded not only greater uniformity of results, but also an opportunity to determine the reduction in yield caused by the disease during a second generation of plants.

Observations made in 1925 and 1926 revealed the following information concerning the disease under consideration. The disease affects both tubers and vines, and the symptoms manifested by these structures appear to vary, *i.e.*, the vines may show evidence of the disease while tubers from the same plant appear normal, and vice versa. It is quite probable that soil and seasonal conditions bring about certain of these variations, but, under the limited scope of the investigation, a study of the factors responsible for such variations was not afforded. Vine symptoms appear more marked in the Irish Cobbler than in the Green Mountain variety, thus affording readier detection of the disease in the former. The plant is laterally dwarfed, having sharp angles between the leaf petioles and stem, thus giving the vine a staring, upright appearance. The colour of the foliage is generally darker than that of normal plants. The leaf surface is restricted and, in advanced stages of the disease, the leaves may show a rugosity and inrolling of the margins. The mid-ribs of lateral leaflets

* These tubers were from the corresponding halves of tubers used in the first instance for tuber-grafting operations.



1

2



3



4

PLATE 6.—“SPINDLE TUBER” DISEASE OF POTATOES

Fig. 1.—Plant showing evidence of disease.

Fig. 2.—Normal plant of same variety.

Fig. 3.—Normal and spindle tubers, Green Mountain.

Fig. 4.— Normal and spindle tubers, Irish Cobbler.

occurring at the top of seriously affected plants are sometimes inwardly curved so that these leaflets tend to overlap each other and the terminal leaflet as well, giving the leaf what is popularly called a "bow-legged" appearance. The main petiole of diseased plants is frequently more slender than that of normal ones and may become slightly brittle as the disease progresses. The tubers from spindle-tuber plants are abnormally elongated and cylindrical or spindle shaped, a feature which gives the disease its name. Tubers affected with spindle-tuber are generally irregular in outline and may be pointed at either the seed or stem end. The skin of diseased tubers is smoother and more tender than that of normal tubers, a condition which renders the same susceptible to surface injuries. The eyes are more numerous, longer, and shallower than those occurring in normal tubers, and cases have been observed where the eyes were very conspicuous, the brows protruding considerably above the tuber surface. Figures 1 and 2, Plate 6, convey in a measure the general appearance of a spindle-tuber vine as compared with that of normal plant, while figures 3 and 4, Plate 6, show the general tuber symptoms characteristic of the disease.

Transmission of the disease was effected by the following methods which corroborate the findings of other investigators elsewhere. (a) mutilating the leaves of healthy plants and rubbing the juice from diseased plants into the abrasions so made (b) injecting juice from diseased plants into the petioles and leaves of healthy plants with a hypodermic syringe (c) grafting one-half of a diseased tuber on half of a healthy tuber, and also grafting healthy eyes into diseased tubers* (d) insect vectors; placing aphids or plant lice which had fed on diseased plants on healthy ones. All attempts to transmit the disease, by root and vine contact, cutting knives, and planting healthy tubers in soil inoculated with juice from diseased tubers, proved unsuccessful. In every case where transmission was effected no symptoms occurred on the vines the first season, but in a few instances, however, slight tuber symptoms were observed the first year. The spread of the disease under ordinary field conditions was studied by collecting separately different hills of potatoes grown at different distances from diseased hills and planting the same the following season, to detect any evidence of disease occurring in plants grown from such hills. The results obtained proved that hills far removed from infected plants contracted the disease to a lesser extent than those in close proximity to the source of infection, indicating a distinct correlation between the measure of isolation and dissemination of the disease.

A comparative test of the amount of tubers produced by healthy and diseased plants revealed that spindle-tuber has a marked effect upon the yield, reducing the same 14 and 9 per cent the first season, 36 and 29 per cent the second season, respectively, in the strains of Irish Cobbler and Green Mountain tested under the controlled conditions of this experiment.¹ The results obtained, however, warrant the following conclusions. Spindle-tuber is an undesirable disease, the effects of which are two-fold: it depreciates the market quality of potatoes by producing abnormally-shaped tubers, and causes a pronounced reduction in yield, the combined effects of which result in a loss so considerable, that the economic importance of the disease should not be disregarded.

Efforts to control or eliminate the disease by practical methods warrant the following recommendations. All abnormally shaped tubers, such as manifest typical symptoms of the disease, should be eliminated from potatoes intended for seed purposes. The exclusive use of certified seed will in large measure achieve this end. All plants showing vine symptoms should be rogued as soon as noted to preclude natural spread of the disease. The judicious use of nico-

* See this report 1925, P. 46.

¹ A project will be inception in 1927 employing more practical and representative methods as opposed to the refined technique employed in this experiment, with the view to securing results more significant to the average grower.

tine sulphate, either in the form of spray or dust, will aid materially in controlling aphids or plant lice, incidentally preventing dissemination of the disease by these agencies. Potatoes intended for certification, particularly should be thoroughly isolated, or sufficiently far removed from an uncontrolled source of infection, to ensure adequate protection from the disease as transmitted by insects.

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EARLY BLIGHT TUBER ROT OF POTATOES

During the autumn season of 1924, specimens of an unusual tuber rot occurring in certain Green Mountain potatoes were brought to the attention of this laboratory by the seed potato inspectors operating in this province. Although the condition was not sufficiently prevalent to consider the same of prime importance at the moment, it was deemed advisable to investigate the matter, so that information concerning it would be available in the event of its proving of serious consequence in the future. To this end, a pathological examination was made of affected tubers, which resulted in the isolation of certain cultures of *Alternaria* and *Fusarium* from the lesions occurring on such tubers. A further study of these organisms, conducted in accordance with the systematic methods generally employed in the identification of fungi, revealed that the former were *Alternaria Solani*, and the latter *Fusarium oxysporum*, *F. trichothecioides*, *F. coeruleum*, and certain other species of this organism commonly occurring in dry rot of the potato tuber. Efforts were made to reproduce the condition under consideration by inoculating healthy tubers of both the Green Mountain and Irish Cobbler varieties with the organisms isolated. The methods employed were as follows: (1) The surfaces of freshly dug tubers were smeared with an inoculum containing spores and mycelium of the organisms isolated. (2) The tuber surfaces, including lenticels and eyes, were pricked with a sterilized needle, and some of the inoculum used in the first instance was placed in the small openings so made. (3) Leaves and stems manifesting numerous *Alternaria* lesions were cut into small pieces and placed on the moistened surfaces of young and tender tubers. Each and every tuber thus treated was placed in sphagnum moss or absorbent cotton to ensure thorough retention of moisture and at the same time permit the entrance of an adequate supply of air. Healthy uninoculated tubers of the varieties tested served as checks. The several tubers inoculated, as well as the checks, were placed under both dry and moist conditions at 5° to 10°, 12° to 21°, 23° to 32°, and at 37° Centigrade, respectively. An examination of all tubers under consideration showed that the *Alternaria* produced characteristic lesions on a number of tubers kept under moist conditions at temperatures ranging from 12° to 21° C., while the *Fusarium* cultures failed to infect any of the tubers inoculated. No infection occurred with *Alternaria* at the temperatures considered under dry conditions, and at temperatures ranging from 5° to 10°, 23° to 32°, and 37° C. under moist conditions. No infection took place in any of the tubers serving as checks. Infection was

accomplished by all the methods attempted, but the third proved most efficient, for numerous lesions appeared on tubers so inoculated, while only a few scattered lesions occurred on tubers inoculated by the first and second methods described. The lesions produced on tubers inoculated with *Alternaria* yielded pure cultures of the organism which were subsequently used to reproduce similar lesions of other tubers. Inasmuch as the several cultures of *Fusarium* failed to produce infection, it was deduced that these organisms were not the primary cause of the condition and merely existed in the diseased tissues as saprophytes. Therefore, in the light of the foregoing tests and observations the cause of the disease investigated is attributed to *Alternaria Solani* (See plate 7).

The identification of *Alternaria* cultures isolated was confirmed by spraying the leaves and stems of healthy potato plants kept under bell jars with a suspension containing spores and mycelium from each of the cultures tested. Lesions were produced in several instances which were quite similar to those occurring on plants affected by *Alternaria* under ordinary field conditions, with the exception that they were considerably smaller in size.

In order to determine whether infected tubers are capable of transmitting the disease from one generation to another, tubers manifesting typical symptoms were planted in flower pots and kept under glass-covered boxes affording the necessary protection from external sources of infection. In no case, however, was any evidence of the disease observed either on the above-ground parts of the plant or resulting tubers.

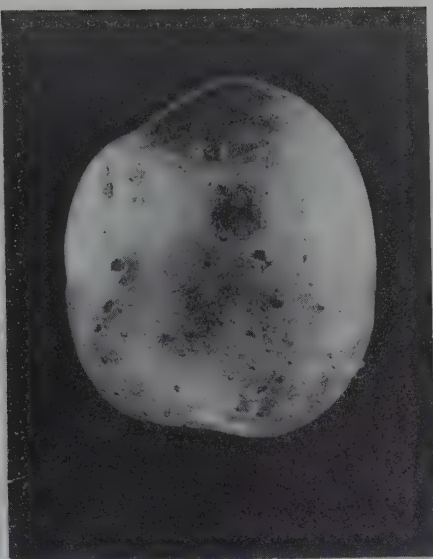
The following embodies an outline of the disease and its symptoms as they were observed. The fungus appears to gain entrance chiefly through the lenticels, and in its incipient stages occurs as a small, brown, more or less circular, necrotic area surrounding these orifices. As the disease progresses the lesion becomes somewhat depressed and irregular in outline with a slightly raised margin. As a rule the lesions do not penetrate deeply into the internal tissues of the tuber nor enlarge in area more than a square centimeter. The transition from diseased to healthy tissue is frequently so abrupt, the infected area can be removed intact, leaving a shallow depression; a feature which gives the disease the popular name "pocket rot" among those who are sufficiently observant to recognize it. The accompanying photographs (plate 7) show the typical symptoms of the disease as it occurs on the foliage, and both its incipient and advanced stages on the tuber.

The optimum temperatures for the development of the disease range from 12° to 20° C. The disease progresses very slowly at first, but eventually, by the combined effects of the primary fungus and commonly occurring decay-producing organisms, ultimate decomposition of the tuber may result. This particularly obtains when sufficient moisture is present to enhance growth of the organisms concerned. Tubers affected by the disease and kept under dry conditions, however, will deteriorate very slowly, thus impairing the health of such tubers only to a slight extent. Infection of tubers appears to occur early in the season when the tuber surfaces are still very tender and the temperature ranges from 12° to 21° C. It is quite probable that such infection is brought about during a season when the disease is severe, incidentally resulting in large quantities of *Alternaria* spores and mycelium coming in contact with the tubers during their removal from the soil at harvesting time.

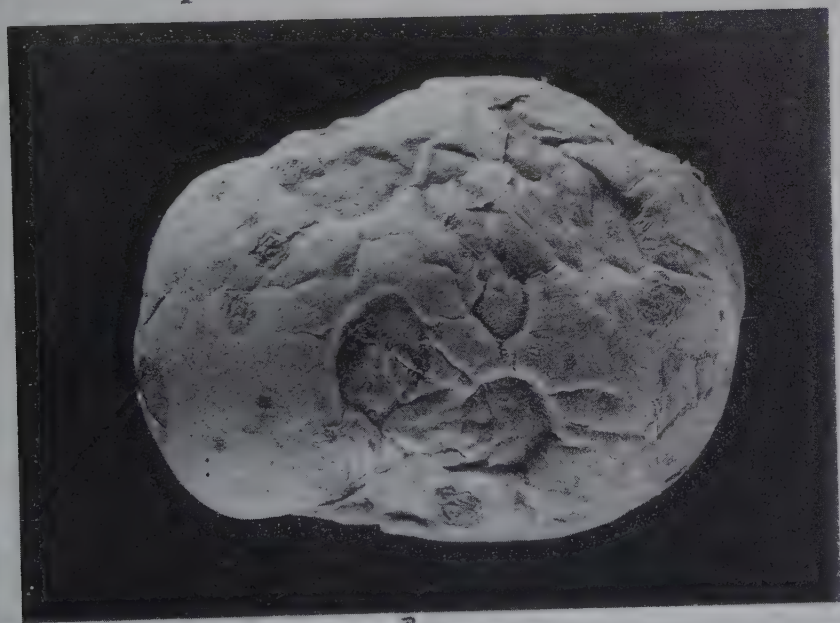
The Green Mountain and Irish Cobbler strains used for the purpose of the experiment appear to be equally susceptible to the disease as it occurs on the tuber. The disease, however, has not been sufficiently prevalent during the three seasons it has been under observation, to warrant considering the same of any serious consequence, and the fact that it was not in evidence during other seasons would seem to indicate that certain seasonal conditions are responsible in some measure for its occurrence.



1



2



3

PLATE 7

Fig. 1.—Potato leaf showing early blight.

Fig. 2.—Early blight lesions on potato tuber, incipient stage.

Fig. 3.—Early blight lesions on potato tuber, advanced stage.

All the cultures of *Alternaria* isolated from diseased tissue did not produce infection in the tubers tested, which would seem to indicate that only certain strains of the organism are sufficiently pathogenic to attack the tuber tissues.

Preventive measures for the disease as it occurs on tubers have not been determined but, owing to its similarity to that caused by *Phytophthora infestans*, popularly called "late blight," control measures for the latter might well be applied to the former, i.e., all tubers manifesting symptoms of the disease should be eliminated from potatoes intended for seed, and consistent applications of Bordeaux, either in the form of dust or spray, will in large measure prevent the disease from attacking the foliage, incidentally precluding infection of the resulting tubers.

The disease as described appears to be exactly similar to a condition reported by Folsom and Bonde in the State of Maine during 1922, and subsequently determined by these investigators in 1925 as attributable to *Alternaria Solani*.

The staff of this laboratory gratefully acknowledge the valuable suggestions offered and assistance tendered by the aforementioned investigators, which rendered possible a more comprehensive and detailed investigation of this disease.

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SCLEROTINIA DISEASE OF HOLLYHOCK, *Althea rosea* CAV.

During the latter part of August, 1926, a destructive disease affecting hollyhocks in the Experimental Station flower garden came under the observation of Mr. J. K. Richardson, assistant plant pathologist at this laboratory. A critical examination of diseased plants revealed, by the constant association of mycelial threads and numerous sclerotia with affected parts, that the condition was of fungal origin. As the season advanced the disease continued to spread, with the result that, eventually, all the hollyhock plants in a certain section of the perennial border manifested evidence of infection; many of them ultimately succumbed to the ravages of the disease. Other hosts in close proximity to diseased hollyhocks also became infected and showed in each case symptoms quite similar to those occurring in the case of the latter. Several plants in each case shared a similar fate to the hollyhocks as a result of the disease under consideration. The other hosts affected are as follows: *Helianthus tuberosus* Lin.; *Zinnia elegans*; *Matthiola incana*, var., *annua*. The following is an outline of the disease as occurring in hollyhocks:—Initial infection may occur anywhere on the above-ground parts of the plant. The incipient stage of the disease is characterized by the occurrence of a small, dark, slightly sunken, necrotic area, developing, generally, at the junction between a leaf or flower petiole and the main stem of the plant. Primarily, the lesion so produced does not penetrate deeply into the internal tissues but confines itself to the epidermal layer. Subsequently, as the fungus progresses (see plate 8), the lesion becomes elongated, eventually attaining a length of ten to thirty inches and at the same time extends laterally until the stem is completely girdled, incidentally resulting in the death of the upper parts of the plant. Coincidentally with a progressive increase in the size of the lesion, the colour of affected tissues changes from a black to a brown, finally to a light grey, giving the diseased area a characteristic appearance. Under optimum conditions of temperature and humidity, a web of fine, white mycelium, coextensive with the lesion, surrounds the stem. This feature, for



PLATE 8.—Arrows showing progressive stages of Hollyhock *Sclerotinia* Disease from incipency to ultimate destruction of the plant.

obvious reasons, is entirely absent when hot, dry conditions obtain. As the lesion increases in size an abundance of mycelium develops in the interior of the affected portion of the stem, resulting in disintegration of the cells involved. Subsequently the mycelium aggregates into oblong-shaped sclerotia of various sizes, which sometimes fill the cavity within the stem. During the early stages of the disease the epidermis remains intact but eventually becomes erupted, due to the expanding force created by the development of sclerotia in the sub-epidermal layer, producing a retting of the surface tissues, and ultimately resulting in a complete collapse of the stem at this point.

The fungus was easily cultured from sclerotia by dipping the same in alcohol and then in corrosive sublimate (1-1000) for three minutes, subsequently washing in sterile water and planting on agar. Fragment cultures from infected tissues were also successful. The organism grows vigorously on ordinary culture media and produces an abundance of black, oblong-shaped, sclerotia with irregular surfaces. They range in size from 2 to 15 millimeters in length and 1 to 5 millimeters in diameter. The mycelium is white, and the hyphae are 3 to 7 microns in diameter, hyaline, septate, and sparsely branched. Attempts to reproduce the disease by inoculating the stems of hollyhock plants with a pure culture of the organism succeeded in each case. The organism was recovered from certain stems thus inoculated, and identified as similar to that causing the disease originally. The fungus causing the disease appears to be a *Sclerotinia*, but sufficient evidence is not available to warrant identification of the particular species involved.

Further work upon the disease is proposed with a view to confirming the results already obtained, securing further knowledge concerning the disease as affecting other plants, and developing control measures, if possible.

COMPARISON OF CERTAIN SEED TREATMENTS FOR THE CONTROL OF OAT SMUT

Oats being the most important cereal crop grown in the province, a study of preventive measures for a destructive disease, such as smut, attacking the same was deemed imperative. The methods accorded general usage for the control of this disease consist of treating the seed with certain chemicals which destroy the smut spores adhering to the kernels, thus precluding, in a measure dependent upon the efficiency of the treatment employed, development of the disease. During the past decade a large number of chemical compounds have appeared on the market, the manufacturers of which claim such as being possessed of certain especial merits for the control of cereal smuts. The aim of this investigation is, therefore, to determine and compare the fungicidal values of a number of these compounds for the control of oat smut, in particular under the conditions obtaining in this province.

Two varieties of oats were used for the experiment, namely Victory and Laurel; the former because it is commonly grown in the province and also by virtue of its protective hull affords a certain measure of resistance to smut, while the latter, by way of contrast, being hullless, appears to be more susceptible to the disease. A definite quantity of seed of each variety chosen for the purpose was heavily and uniformly inoculated with smut collected the previous season. Each lot of inoculated seed was divided into 20 gram quantities, each of which was treated with one only of the compounds tested. Similar quantities of the untreated inoculated seed and uninoculated seed served as checks. All quantities of seed under consideration were sown in rows two rods long. The several rows, including checks, were systematically replicated. All the heads in each row were counted when estimating the amount of smut occurring. The Victory variety was sown on June 11 and Laurel on June 12. Table 7 embodies a list of the several chemicals tested, methods of application, and the results obtained.

TABLE 7

Chemical	Application		Victory		Laurel	
	Rate	Method	Time of emergence in days	% Smut	Time of emergence in days	% Smut
Nickel hydrate (caustic precipitation).....	3 oz. per bu.	Dust (1).....	7	3.06	7	4.78
Nickel hydrate (lime precipitation).....	"	"	7	1.62	7	2.21
Nickel sulphide (Deloro).....	"	"	7	0.00	7	0.33
Nickel carbonate (Deloro).....	"	"	7	1.58	7	5.57
Dust collector Paris Green (Deloro).....	"	"	9	0.00	10	0.31
Paris Green.....	"	"	9	0.00	10	0.75
Copper sulphate (dehydrated).....	"	"	7	0.22	10	0.00
Copper carbonate.....	"	"	7	1.06	8	2.09
Dupont Semesan.....	"	"	7	0.54	7	0.72
Dupont Semesan No. 15.....	"	"	7	0.00	7	0.35
Dupont Semesan Z1.....	"	"	7	0.25	7	1.58
Dupont Semesan Z4.....	"	"	7	0.10	7	0.42
Dupont Dust Disinfectant No. 12.....	"	"	7	0.13	9	0.12
Dupont Dust Disinfectant No. 13.....	"	"	7	0.21	9	0.34
Dupont Dust Disinfectant No. 15.....	"	"	7	0.12	7	1.48
Dupont Dust Disinfectant No. 42.....	"	"	11	0.00	14	0.00
Dupont Dust Disinfectant No. 46.....	"	"	7	0.05	9	1.73
Dupont Dust Disinfectant No. 49.....	"	"	7	0.42	7	0.12
Dupont Dust Disinfectant No. 57.....	"	"	7	0.00	9	1.85
Sulphur.....	6 oz. per bu.	"	7	0.00	8	0.76
Germisan.....	2 oz. per bu.	"	9	0.00	10	0.00
Uspulun.....	2 oz. per bu.	"	7	0.34	8	0.00
Germisan.....	0.25 % solution	0.5 hr. dip.....	9	0.00	10	0.00
Uspulun.....	"	"	7	0.00	7	0.00
Formaldehyde.....	1 part in 320....	Sprinkle covered 4 hours.....	10	0.00	11	0.00
Formaldehyde.....	1 part in 1.....	Spray Covered 4 hours.....	10	0.00	11	0.00
Dupont Semesan.....	0.25 % solution	1 hr. dip.....	7	0.00	7	0.00
Dupont Semesan Bel.....	0.25 "	"	7	0.00	7	0.00
Dupont Semesan No. 15.....	0.25 "	"	7	0.00	7	0.00
Dupont Semesan Z1.....	0.25 "	"	7	0.00	7	0.00
Dupont Semesan Z4.....	0.25 "	"	9	0.28	10	0.61
Dupont Dust Disinfectant No. 12.....	1 part in 1000...	0.5 hr. dip.....	7	0.28	7	0.00
Dupont Dust Disinfectant No. 42.....	1 part in 1000...	0.5 hr. dip.....	7	0.00	9	0.00
Check (smut inoculated).....			7	4.42	7	8.46
Check (uninoculated).....			7	0.00	7	0.49
Check (smut inoculated) (2).....			7	4.13	7	9.77

(1) The finely powdered chemical was shaken with the seed in a glass jar to insure uniform application.

(2) The seed was soaked in water for three hours before inoculation with smut then sown while still moist.

While the results of the present season's investigation afford a brief comparison of the efficiency of the respective treatments considered, it would be manifestly inequitable to deduce final recommendations until the experiment has been conducted for a number of seasons, so that the several factors entering into a problem of this type can be studied in detail.

DUSTING VS. SPRAYING

During the season 1925 an experiment was conducted at this laboratory for the purpose of comparing the respective fungicidal merits of Bordeaux liquid and dust mixtures for the control of foliage diseases of the potato. The

results of this experiment revealed in some measure that slightly better protection was afforded in the locality where the investigation was conducted during that particular season with the use of Bordeaux dust as applied by a traction machine. The nature of such a test renders it unwise to deduce final recommendations from a single season's results, obtained moreover in only one locality. Bearing this in mind the experiment was repeated in 1926 in the same locality, but on the farm of another grower, where a slightly different set of conditions obtained, that the several divergent factors entering into a problem of this sort might be more comprehensively and equitably considered. The method employed in this instance was similar to that followed in 1925, a detailed outline of which may be found in the report of this laboratory for that year. The materials tested, however, included, in addition to Bordeaux applications, copper carbonate in both the form of dust and liquid, which was supplied by the Entomological laboratory.¹ The following table embodies an outline of the several applications received by the respective plots, including check.

TABLE 8

Date	Plot 1 Check 20 per cent Calcium arsenate (¹)	Plot 2 Bordeaux dust. 5 per cent metallic copper	Plot 3 Copper Carbonate dyst. 49 per cent metallic copper	Plot 4 Bordeaux spray 0.245 per cent metallic copper	Plot 5 Copper carbonate spray 0.245 per cent metallic copper	Plot 6 Bordeaux dust (Farmer's regular treatment)
July 26	15 lb. Poison dust.	17 lb. 20-20-60	20 lb. 20-14-66	80 gals. 4-4-40 2½ lb. Calcium Ar- senate.....	80 gals. 2-4-40 2½ lb. Calcium Arsenate.....	.....
" 29	.....	.....	.....	.....	.....	15 lb. 20-20-60.
Aug. 2	12 lb. Ditto.....	15 lb. Ditto...	18 lb. Ditto...	80 gals. Ditto.....	80 gals. Ditto...	.....
" 4	.....	.....	.....	.....	.....	14 lb. 20-20-60.
" 10	0	13 lb. Ditto...	25 lb. Ditto...	80 gals. Ditto.....	80 gals. Ditto.....	.....
" 16	14 lb. Ditto.....	23 lb. Ditto...	32 lb. Ditto...	80 gals. Ditto.....	80 gals. Ditto...	20 lb. 20-20-60.
" 23	0	27 lb. 20-80...	30 lb. 14-86...	80 gals. Ditto.....	80 gals. Ditto.....	.....
" 27	.....	.....	.....	.....	.....	30 lb. 20-80.
" 30	0	23 lb. 20-80...	34 lb. 14-86...	80 gals. Ditto.....	80 gals. Ditto.....	.....
Sept. 9	0	35 lb. 20-80...	32 lb. 14-86...	80 gals. Ditto.....	80 gals. Ditto...	20 lb. 20-80.
" 15	0	48 lb. 20-80...	39 lb. 14-86...	80 gals. 4-4-40...	80 gals. 2-4-40...	.....

¹ The check plot was of necessity protected against ravages of insects.

Six plots were used for the experiment, five of which comprised one acre each, while the sixth—serving as a check—included only half an acre for obvious reasons. The land used was of average fertility, and of slightly higher elevation than that used in 1925. Certified Green Mountains were used. Rainfall was ample during the growing season, and an excellent stand was obtained. Early blight was first recorded on August 23. Subsequent to that date a slight uniform spread occurred, such that, by September 1, the several plots were equally affected by the disease. No increase was observed in any of the plots after the latter mentioned date. Late blight was first recorded in isolated patches in plots one and five on August 16, in plot four on August 23, and in plots two, three, and six on September 1. Infection spread rapidly in plots one, three, and five, and slowly in plots two, four, and six. Observations made on October 1 revealed that the vines in plots one and five had entirely succumbed to the ravages of the disease; those in plot three were partially dead; while

¹ This experiment was conducted during 1926 in collaboration with the Entomological Laboratory at Fredericton, where a similar project has been in progress for a number of seasons under the supervision of Mr. G. P. Walker.

those in plots two, four, and six manifested only slight infection, and were still quite green and vigorous. Colorado beetles were prevalent during the early part of the growing season, but timely applications of calcium arsenate very effectually held them under control. Leaf hoppers and flea beetles were comparatively few in numbers, so that no apparent damage was caused by these insects. When the first application was given on July 26 the plants in plots four, five, and six appeared slightly more vigorous compared with those in one, two, and three. On August 16, however, no apparent difference could be observed in the vigour of plants growing in the several plots under consideration. The vines in plot one succumbed eight days previous to those in plot five. Harvesting of the several plots was performed from the 11th to the 15th of October. The following table includes the results obtained, as well as final field readings recorded on October 1.

TABLE 9

Plot No.	Fungicide	Number of applications	Amount metallic copper	Field readings Oct. 1st.		Percentage number of Late Blight tubers	Total yield of Blight free tubers per acre in barrels
				Early Blight	Late Blight		
1	Check.....	3	.....	Slight	Very severe	10.86	94.6
2	Bordeaux dust.....	8	10.05	"	Slight	0.26	103.6
3	Copper carbonate dust.....	8	11.27	"	Moderate	0.96	99.7
4	Bordeaux.....	8	16.00	"	Slight	0.50	111.4
5	Copper Carbonate Spray.....	8	16.00	"	Severe	0.78	104.8
6	Bordeaux dust (Farmers' regular treatment) ¹	5	4.95	"	Slight	0.44	100.1

¹ A dust schedule as ordinarily practised by growers was included for additional comparison.

The foregoing results, insufficient as they may seem, are self-explanatory. Caution, however, must be exercised in their interpretation, lest they should purport to convey designs for convincing rather than the presentation of facts and their probable representativeness. While these results reveal insufficient differences in the fungicidal values of Bordeaux dust and liquid mixtures as applied to warrant specific recommendations with respect to either, nevertheless local conditions will determine the expediency of using one or the other. Finally, as regards the respective fungicidal merits of copper carbonate as opposed to copper sulphate, the results obtained show, under the specific conditions prevailing, the marked superiority of the latter.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, STE. ANNE DE LA POCATIERE, P.Q.

(H. N. Racicot, Officer in Charge)

The season was marked by a very late spring, an unusual amount of cloudy weather, dry periods in July and August, and a very wet fall. On the whole the season was favourable to the development of plant diseases, but, with two exceptions, no serious outbreak occurred, and the losses were moderate in all cases. The two exceptions mentioned above were cereal rusts and late blight of potatoes. There was three or four times as much of both stem and leaf rust of cereals this year as during any of the three previous years. Only the lateness of its appearance, when the cereals were approaching maturity, saved the crops from heavy losses. In a few cases only was there much damage noted. In the case of late blight of potatoes, heavy outbreaks occurred in a few localities, where growers sustained considerable loss due to tuber rot at harvest time. But taking the whole province into consideration the losses were moderate. Two other facts are worth noting. One was the low percentage of black leg on potato vines and the almost total absence of tuber rot due to this disease at harvest time. The other was the appearance of apple scab, due to very wet weather, in some well sprayed orchards, after the date beyond which it is considered unnecessary to spray.

LATE BLIGHT OF POTATOES (*Phytophthora infestans* (Mont.) de B.)

Another plot was added to the experiment on spraying with Bordeaux mixture to determine the time and number of applications for the control of late blight of potatoes in this district, and the effect of Bordeaux mixture upon the yield in blight-free years. This additional plot was used to test a preparation known under the trade name of "Pota", which is applied in dust form. Six plots were sprayed every ten days with 4-4-40 Bordeaux mixture, one plot was dusted every ten days with "Pota", and the eighth plot left untreated. There was much dry weather during July and the first half of August, during which the potato vines suffered considerably. The plots that were sprayed or dusted during these dry periods withstood the drought better, and gave higher yields than the plots not treated, or those which were sprayed only after the dry weather. For two years in succession, plots sprayed with Bordeaux mixture survived drought better and gave higher yields than plots not sprayed during such weather. No trace of late blight appeared on either vines or tubers this year.

SPRAYING POTATOES WITH BORDEAUX MIXTURE AND DUSTING WITH "POTA"

Plot	Number and time of application	Yield, bus. per acre	
		Total	Marketable
	<i>Bordeaux mixture</i>		
1	Control, unsprayed.....	172	114
2	4, beginning June 30.....	233	166
3	6, beginning June 30.....	203	146
4	4, beginning July 20.....	169	117
5	6, beginning July 20.....	185	136
6	4, beginning Aug. 10.....	168	125
7	6, beginning Aug. 10.....	147	97
	<i>"Pota"</i>		
8	8, beginning July 10.....	194	138

OBSERVATIONS ON THE VIRUS DISEASES OF POTATOES

Owing to the fact that the Nicotine Sulphate dust used in 1925 did not control aphids, and to the superabundance of the latter, there was such an increase in the percentage of mosaic this year in the healthy plot that it was necessary to omit the experiment to determine the progress in the severity of potato mosaic, as determined by the yield, when the diseased plants are not rogued. This experiment will be undertaken again next season with healthy seed.

Demonstration plots were again set out at Luceville, Rimouski Co., this year, to prove to growers in this district, who still believe otherwise, that mosaic reduces the yield. One plot was planted with healthy seed and the other with mosaic seed, both in duplicate.

TABLE 10

Plot	Per cent Mosaic	Yield, bus. per acre	Per cent decrease
Healthy seed.....	2	348	.....
Mosaic seed.....	89	203	41.7

COMMON SCAB OF POTATOES, *Actinomyces scabies* (THAX.) GÜSSOW

Soil treatment with inoculated sulphur to control common scab was again carried out at Ste-Anne de la Pocatière. The sulphur was broadcast over the plots and worked into the soil. The seed used was scabby tubers of the Green Mountain variety. The results obtained are as follows:—

TABLE 11

Lbs. of sulphur per acre	Per cent clean	Per cent saleable scabby	Per cent unsaleable scabby	Yield, bus. per acre	
				Total	Market-able
0.....	4.2	68.5	27.3	352	293
300.....	18.7	68.0	13.3	308	243
450.....	6.5	72.8	20.7	358	298

The average of the results for the three years of 1924-26, shows that, for the soil and other external conditions at Ste-Anne, inoculated sulphur does not sufficiently control common scab to warrant the expense of its purchase and application. The results, however, appear to vary with the locality or the nature of the soil. Inoculated sulphur decreased the amount of scab by about 10 per cent at Ste-Anne de la Pocatière, Kamouraska Co., and by about 15 per cent at Bic, Rimouski Co. It had no effect at Notre-Dame du Sacré-Coeur, Rimouski Co., and it reduced the amount of scab at Rivière Blanche, Matane Co., by about 30 per cent. The soil at Rivière Blanche is of fluvial deposit, containing 30 per cent or more of calcareous shells. The table below gives the average results for these four localities.

TABLE 12

Locality	Variety	Lbs. sulphur per acre	Per cent clean	Per cent saleable scabby	Per cent unsaleable scabby
Ste-Anne.....	Green Mountain.....	0	9.1	72.3	18.6
		300	8.9	78.4	12.7
		450	19.6	68.4	12.0
Bic.....	Green Mountain.....	0	31.0	69.0	0
		300	47.5	52.5	0
Sacré-Cœur.....	Irish Cobbler.....	0	38.5	61.5	0
		300	34.5	65.5	0
Rivière Blanche.....	Unknown.....	0	25.0	75.0	0
		300	45.0	55.0	0
		450	54.0	46.0	0

Chemicals and commercial seed-disinfectants were also tested for the control of common scab. Scabby tubers of the Green Mountain variety were treated and planted in 50-foot rows, in duplicate. Evidently the soil in which this experiment was located must have been infected with the common scab organism, as the percentage of scab was very high in all cases. The results obtained are given below.

TABLE 13

Row	Treatment	Yield, bush. per acre		Per cent scabby
		Total	Market- able	
1	Control, scabby tubers, untreated.....	159	102	90.9
2	Mercuric bichloride, 1-1000, immersed 1½ hours.....	199	145	89.5
3	Formalin, 1 pt. in 30 gallons, immersed 1½ hours.....	226	158	97.7
4	Semesan, dust, 3 oz. per bushel.....	202	142	93.5
5	Semesan, liquid, 0.25 per cent sol., immersed 30 minutes.....	207	134	89.1
6	Control, clean seed, untreated.....	320	261	86.2
7	D.D.D. No. 15, dust, 3 oz. per bus.....	209	144	71.5
8	D.D.D. No. 12, liquid, 0.25 per cent sol., immersed 30 minutes...	218	142	82.7
9	Uspulun, 0.25 per cent sol., immersed 30 minutes.....	209	142	72.2
10	Control, scabby tubers, untreated.....	186	131	87.5
11	D.D.D. No. 12, dust, 3 oz. per bushel.....	145	90	87.0
12	Dupont Semesan Bel, 2 oz. per bushel.....	141	90	93.8
13	Acidulated mercuric chloride; mercuric chloride 1-1000, hydrochloric acid 0.5 per cent, immerse 2 minutes, cover for 24 hours	170	110	95.7

OAT SMUTS, *Ustilago Avenae* (PERS.) JENS. AND *U levis* (K. & S.) WAGN.

Further tests were made to determine the value of commercial seed-disinfectants placed on the market, and recommended to control oat smuts. Seed oats harvested from a field containing oat smuts were treated and sown in 1/480 acre plots in triplicate. The data obtained are from three counts of 100 heads in each plot. On account of a horse straying at night into the experimental plots and mixing all the sheaves, the yield was not recorded. The results are given below.

TABLE 14.—VARIETY:—LAUREL HULL-LESS

Row	Treatment	Per cent germ-ination	Per cent smut
1	Control, untreated.....	55.5	0.3
2	Wet Formalin, 1 pt. in 30 galls., immersed 5 minutes, drained, covered 1 hour.....	0	0
3	Dry Formalin, 1 pt. per 50 bushels, covered 2 hours.....	0	0
4	Uspulun, 0.25 per cent sol., immersed 2 hours.....	55.5	0
5	Semesan, liquid, 0.3 per cent sol., immersed 2 hours.....	59.	0
6	Semesan, dust, 3 oz. per bushel.....	39.	0
7	Dupont Dust Disinfectant, No. 12, liquid, 0.33 per cent sol., immersed 2 hours.....	62.5	0
8	Dupont Dust Disinfectant, dust, No. 12, 3 oz. per bushel.....	48.	0
9	Dupont Dust Disinfectant, dust, No. 13, 3 oz. per bushel.....	67.	0
10	Control, untreated.....	40.5	1.7
11	Copper carbonate dust, 4 oz. per bushel.....	69.	0
12	Sulphur dust, 6 oz. per bushel.....	22.	0
13	Copper sulphate, powdered, and lime, equal parts, 4 oz. per bushel.....	68.	0.3
14	Dupont Dust Disinfectant, No. 17, dust, 3 oz. per bushel.....	22.	0.7
15	Bayer Compound, liquid, 0.25 per cent sol., immersed $\frac{1}{2}$ hour.....	82.5	0
16	Bayer dust, 2 oz. per bushel.....	11.0	0.3
17	D.D.D. No. 16, 3 oz. per bushel.....	66.5	0.0
18	D.D.D. No. 42, 1-1000, immersed 30 minutes.....	67.5	0.0

TABLE 15.—VARIETY:—BANNER, CAP ROUGE STN.

Row	Treatment	Per cent germ-ination	Per cent smut
1	Control, untreated.....	86.0	1.4
2	Wet Formalin, 1 pt. in 30 galls., immersed 5 minutes, drained, covered 1 hour.....	9.5	0.0
3	Dry Formalin, 1 pt. per 50 bushels, covered 2 hours.....	0.0	0.0
4	Uspulun, 0.25 per cent sol., immersed 2 hours.....	71.5	2.9
5	Semesan, liquid, 0.3 per cent sol., immersed 2 hours.....	81.0	2.5
6	Semesan, dust, 3 oz. per bushel.....	89.5	3.0
7	Dupont Dust Disinfectant, No. 12, liquid, 0.33 per cent sol., immersed 2 hours.....	95.5	0.9
8	Dupont Dust Disinfectant, No. 12, dust, 2 oz. per bushel.....	76.5	0.1
9	Dupont Dust Disinfectant, No. 13, dust, 3 oz. per bushel.....	93.5	0.0
10	Control, untreated.....	88.0	0.0
11	Copper carbonate dust, 4 oz. per bushel.....	99.0	0.7
12	Sulphur dust, 6 oz. per bushel.....	88.5	0.4
13	Copper sulphate, powdered, and lime, equal parts, 4 oz. per bushel.....	92.5	0.5
14	Dupont Dust Disinfectant, No. 17, dust, 3 oz. per bushel.....	95.5	0.8
15	Bayer Compound, liquid, 0.25 per cent sol., immersed $\frac{1}{2}$ hour.....	93.5	3.6
16	Bayer Dust, 2 oz. per bushel.....	94.0	1.8
17	Dupont Dust Disinfectant, No. 16, 3 oz. per bushel.....	87.0	0.0
18	Dupont Dust Disinfectant, No. 42, 1-1000, immersed 30 minutes.....	89.0	0.5

BEAN MOSAIC

In regard to the project on the transmission, in the field and through the seed, of bean mosaic, it is interesting to note that plants from diseased seed, and which had been diseased for at least three generations, showed no symptoms of mosaic this year, except about half a dozen plants, from a total of three hundred. The mosaic rows also gave the same yield as the healthy rows. This unusual condition is believed to be due to the unusual amount of dull cloudy weather during the growing season. The average yield this year was 11.3 bushels per acre for both the healthy and the mosaic beans, compared with 20 bushels per acre for the healthy beans, and 15 bushels per acre for the mosaic beans last year.

RASPBERRY INSPECTION AND CERTIFICATION

A service for the inspection and certification of raspberry plantations in the province of Quebec was inaugurated this year. While the number of applications for inspection was not large, yet the plantations inspected were from all parts of the province, of all sizes and ages, and representative of conditions prevailing throughout the province.

The inspection of plantations revealed the facts that there are mainly two varieties grown, the Herbert and the Newman No. 23, and that the principal diseases present are mosaic and spur-blight. The Herbert is very susceptible to spur-blight, the Newman No. 23 to mosaic, at least under Quebec conditions. A number of plantations were inspected that had been rendered economically useless by these diseases, plantations of Herbert by spur-blight, and of Newman No. 23 by mosaic. The average percentage of mosaic in all the plantations inspected was 21, while the spur-blight in the plantations of Herbert averaged from moderate to severe. A number of plantations inspected contained foreign varieties.

Most of the growers who made application were those who had just begun the cultivation of raspberries, and whose plantations were small, but who hoped to have stock to dispose of in a year or two. These plantations averaged between one and two acres in size. It is hoped that more of the growers, who have large areas under cultivation, and who habitually dispose of quantities of canes each spring for planting purposes, will make application for the services of an inspector, not only to place on the market better quality canes, but to rid their own plantations of disease, and increase the yield and the quality of their berries. It is also advised that all prospective buyers of raspberry canes should ask for certified stock.

As it has been pointed out above, raspberry diseases, especially mosaic and spur-blight, are prevalent in the province of Quebec, and cause considerable loss due to reduction in yield and to poorer quality of berries. Some plantations also contain more than one variety, and this must cause a certain amount of loss when the berries are shipped to market, as part of the berries would ripen faster than the others, causing spoilage. There are also a considerable number of new plantations set out every spring, both through the initiative of growers themselves, and through the activities of the Provincial Horticultural Service. Therefore the service of inspection and certification of raspberry plantations is expected to prevent and reduce the spread of disease, by assisting growers to place on the market practically disease-free canes in larger quantities than it is possible to obtain at the present time, which will be a great advantage to growers setting out new plantations. It will also reduce the amount of disease in present plantations, and thus improve the yield and quality of berries, and also eliminate foreign varieties from plantations.

EXTENSION WORK

In order to make the Laboratory better known among growers throughout the province, and to bring to their attention the services we are capable of rendering to them, about 2,000 circulars on plant diseases were sent out, among which may be noted those on raspberry diseases and inspection of plantations. Addresses were delivered at the meetings of the various farmers' organizations. Plant disease exhibits were shown at the Provincial Seed Fair, held at the College of Agriculture, Ste-Anne de la Pocatière, and at the county fall fairs at Rimouski, Ile-Verte, Notre-Dame du Lac, and St-Pascal.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, ST. CATHARINES, ONT.

(G. H. Berkeley, Officer in charge)

The early season of 1926 was dry and, therefore, unfavourable for plant diseases. However, this dryness gave way to considerable moisture in late summer and early fall, so that weather conditions were then very favourable indeed for many fungous diseases. Apple scab, peach scab, peach and grape mildew were more general this year than last.

The peach crop, particularly in the western section of the Peninsula, was very light due to the severe early frosts of the fall of 1925. On the whole, crops were lighter this year than last and plant diseases were much more general.

The Spray Service inaugurated on a commercial scale in 1925 was again a success in 1926. During its second season, this service had a membership of two hundred growers. This number could have readily been increased by at least fifty had the field men not been two weeks late in getting started. It was necessary to extend the service to include the township of Saltfleet in Wentworth county in order to give the service to growers of that district, who specially requested it. Approximately seven hundred visits were made to the members of the service for inspection of their various crops and to note the development of fungous diseases and insect pests. Twenty circulars were sent to the members regarding the sprays to be applied, the first on March 31, and the final one on August 12. In connection with certain very important sprays, the growers were informed by telephone, in order that the application might be applied in time. The field men were active on the service from April 20 to July 30.

Reports from members of the service once more demonstrated that this service was greatly appreciated by the fruit-growers. Many letters of appreciation have been received at headquarters. That the spray service is of real direct help to the growers is vouched for by the enthusiasm shown for it by its members. The demonstration orchards, supervised by the field men, were again this year almost ideal. In apples and cherries particularly, there was a very decided difference between the demonstration orchards and nearby orchards not in the Spray Service. The season, particularly the latter part, was very favourable for fungous diseases, and that such good results were obtained under these conditions speaks well for the Spray Service. It has been definitely shown, during the last two years, that there is a demand on the part of the growers for this type of service. The Spray Service this year was under the direct supervision of Mr. G. C. Chamberlain, Assistant Pathologist, and he was assisted by Mr. J. Johnson, a second-year student at the Ontario Agricultural College, Guelph. Mr. Johnson was stationed in Grimsby and covered the territory from Vineland west to Winona. Mr. Chamberlain, who was located at Headquarters, not only had direct charge of the territory from Vineland to the Niagara river, but had as well general supervision of the entire territory and service. Mr. Wm. Ross, Entomologist, again kindly acted as consulting Entomologist.

During the year promotions in the staff and additions thereto, in the appointment of Mr. G. C. Chamberlain as Assistant Plant Pathologist, and of another assistant soon to be appointed, have increased our staff so that in future one or more problems in research will be under way continuously. Until now, all research has been more or less neglected during the busy spring and early summer months, due to the rush of field and extension work, which necessitated the attention, more or less, of the entire staff.

The Officer in charge was invited by Dr. J. H. Faull, Professor of Botany, Toronto University, to give a series of lectures to the graduate students on practical plant pathology. Three lectures were accordingly delivered early in January on the following subjects: (1) general plant pathology; (2) sprays, spraying, and the spray service; (3) brown rot and apple scab.

Dr. L. C. Coleman, now Professor of Plant Pathology, Toronto University, spent the past summer with headquarters at this Laboratory, in a study of the dead arm disease of grapes. Dr. Coleman has kindly prepared a short report of this work which will be included here.

The staff have reported this year two diseases believed new to Canada, namely (1) the black heart or *Verticillium* wilt of Apricot, and (2) a *Fusicoccum* canker of English Walnut.

APPLE SCAB

It was planned to again make use of Mr. H. E. Maycock's McIntosh orchard at Vinemount, Ontario, for experimental spraying for the commercial control of Apple Scab. Owing to circumstances, whereby the spraying outfit was not available, as well as to unfavourable wet conditions, the calyx spray was omitted, and a spray was applied seven days later. The orchard was then discontinued as an experimental orchard, but observations were made on the progress and development of scab, which are very interesting when compared with a demonstration McIntosh orchard, which received the regular spray schedule recommended by the Spray Service, applied by their field man. (See B below.)

(A) During harvest time the production of twelve trees receiving spray applications was taken and examined for the presence of scab as follows (line a):—

From a block of twelve trees which had been maintained as a check block receiving no sprays, scab was evidenced as follows (line b):—

No. of apples	Production in bushels	Clean	Slight scab	Severe scab	Insect injury
		Per cent	Per cent	Per cent	Per cent
(a) 4632.....	34	49.4	42.5	4.1	4.0
(b) 1155.....	7	15.8	39.3	39.7	5.2

The sprayed part of the orchard received sprays of lime sulphur 1-40 with the addition of calcium arsenate, excepting the delayed dormant spray, when the arsenate was omitted. The sprays were as follows:—

1. Delayed dormant, applied May 13.
2. Pink spray, applied May 25.

These two sprays were applied according to schedule by the field man of this Laboratory.

3. Calyx spray, omitted June 9.
4. Post calyx spray, applied June 16.
5. Application of dust, applied July 10.

Great difficulty was experienced in applying an effective spray during the post calyx period, and the application was very unsatisfactory.

On June 5 a careful examination in different sections of the orchard failed to show any infections of scab. This would indicate that up to this time the spray applications had given effective protection, as ascospore discharge had first commenced on May 19, and a slight scab infection to the extent of 3.5 per cent was noted on the check trees at this time (June 5).

No doubt the critical time for this orchard this season was during the calyx period. From June 8, when the spray should have been applied until June 18 when the spray was applied, there were six periods of active ascospore discharge and a total precipitation of 1.78 inch spread over six days with a fairly high temperature. (See text fig. 1.) The conditions, therefore, were favourable for heavy infection to take place and, as infection was noted first in the sprayed plots on June 18, it would appear that infection took place first about June 8. The greatly reduced yield of the twelve check trees, compared to the yield of twelve trees receiving spray applications, would further indicate that infection of the flowering parts took place with the resulting drop of the young fruit. In this respect the experience is similar to that of 1925, when a greatly reduced yield resulted in the check plot compared to that of the sprayed plots.

A further important point in the history of this orchard this season is that the regular three weeks spray was delayed till July 10, and in place of a liquid spray, a dust of sulphur-arsenate was applied. The scab recorded on the fruit of the sprayed plots was principally late infection as was shown by the many pin point scab spots. The latter part of July and during the month of August, weather conditions were particularly wet and would account for a considerable amount of late infection developing on the fruit. In the season of 1924 when extensive dusting operations were carried on in this orchard, the resulting crop was worthless from a commercial standpoint; and during this present season the dusting also apparently checked scab development very little. It is thought that, in this orchard where the trees are planted too closely and the foliage is very dense, the air drainage is necessarily poor and, therefore, unsuitable for dusting operations.

In 1925 there was obtained in this orchard, from a timely schedule of spraying operations, an average of 91.2 per cent grade A fruit, which is indicative of what could be obtained in an orchard badly subject to apple scab infection, and it is to be regretted that circumstances prevented a regular adherence to our spraying schedule for this season. Below is cited a demonstration orchard (B) of McIntosh apples, which received the regular schedule of sprays recommended and applied by the field men of the Spray Service, and from which 83.2 per cent of grade (A) fruit was obtained, which is in striking comparison to the percentage of grade (A) fruit obtained from the above orchard. (B). A second orchard comprising McIntosh apples owned by Mr. M. C. Sackrider, Jordan, Ontario, was sprayed by one of the field men of this Laboratory. The orchard in this case was all treated alike receiving the same sprays as recommended by the spray service; the purpose being to demonstrate the efficacy of the spray schedule.

Delayed dormant, May 13.

Pink spray, May 25.

Calyx, June 8-9.

Three weeks, July 5.

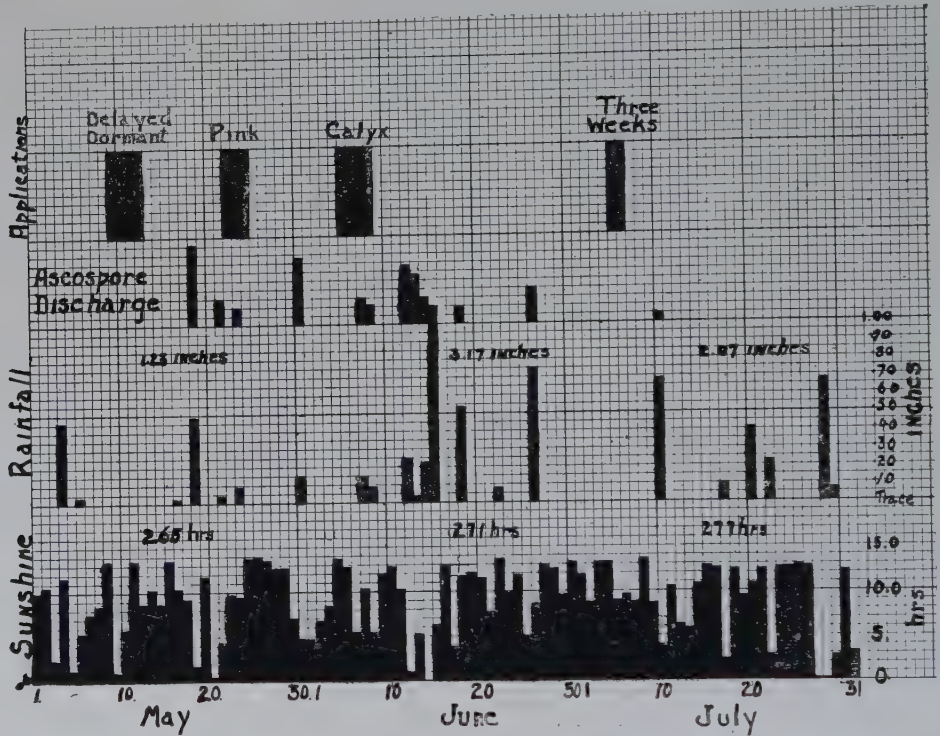
Lime sulphur 1-40 and arsenate of lead were used for all applications, excepting delayed dormant, when arsenate of lead was omitted.

Results are shown in the following table.

No. of apples	Per cent clean	Per cent slight scab	Per cent severe scab	Per cent insect injury
2378.....	83.2	11.0	0.4	5.4

Out of 2,378 apples examined there was 83.2 per cent grade A fruit and less than 1 per cent of severe scab. These results are striking in comparison to those obtained at Mr. Maycock's, even though the layout of the orchards and their respective locations are not altogether comparable. In previous years scab had been a considerable factor in this orchard, and the results of the spray schedule were particularly pleasing. This shows what fine results can be obtained even in a year favourable to scab, if the timing and manner of applying the spray application are correct. Unfortunately it was not possible to maintain a satisfactory check plot in this orchard.

The accompanying chart (Text fig. 1) shows the temperature, precipitation, relative ascospore discharge of the fungus, and the time of application of the sprays for 1926 at St. Catharines, Ontario. There were twelve periods of



ascospore discharge recorded, commencing on May 19 and continuing during periods of precipitation until June 26. It is interesting to note the correlation between rainfall and ascospore discharge on the one hand, and the timeliness of the spray applications related thereto as recommended by the Spray Service.

Scab was generally very well controlled, the early apples being particularly free from scab, although considerable late infection on the fruit developed on the later varieties in certain sections. No infection of the twigs of McIntosh trees was noted after a careful examination of badly infected trees.

SPRAYING FOR SHIPPING QUALITIES OF SWEET CHERRIES

The following spraying was carried out on a block of Sweet cherry trees of the white Oxheart variety, to determine the effect of the various treatments on the keeping qualities of the cherries.

Plot I.—Soluble sulphur, $1\frac{1}{2}$ -50 strength.

Plot II.—Sulphur caseinate, $12\frac{1}{2}$ pounds to 40 gallons.

Plot III.—Lime sulphur, 1-50 strength.

Plot IV.—Check plot—no spray.

The sprays were applied on July 13, and the cherries were harvested on July 19.

In Plot I no spray injury was noticeable on the foliage from the use of the soluble sulphur. No staining of the fruit was evidenced. No rot.

In Plot II particles of sulphur dust were readily noticeable on the cherries. No rot.

In Plot III considerable staining of the fruit was noticed. No rot.

In Plot IV rot was evidenced in a few cases on the trees.

After ten days of ordinary storage conditions the following observations were made.

	No. of cherries	Keeping quality	Per cent rot	Per cent firm	Per cent shrivelled
Plot I.....	198	Fair	22.7	55.5	21.8
Plot II.....	226	Good	8.2	58.9	32.9
Plot III.....	229	Good	6.1	74.3	19.6
Plot IV.....	190	Fair	18.5	61.0	20.5

From two years' experience* (1) with these sprays, it appears that soluble sulphur does not preserve the fruit to quite the same degree as do lime sulphur or sulphur caseinate. From the standpoint of avoidance of marking the fruit, soluble sulphur and sulphur caseinate are equally satisfactory. From the standpoint of preserving the fruit, lime sulphur and sulphur caseinate are equally satisfactory. However, the lime sulphur causes a severe marking of the fruit. Sulphur caseinate is, therefore, the best spray, when both keeping qualities and lack of fruit staining are considered.

BORDEAUX MIXTURE ON SOUR CHERRIES

It was demonstrated by experiments last year (1) that sour cherries from trees sprayed with Bordeaux were considerably smaller in size than those from trees sprayed with lime sulphur. The total crop on such trees was also much less than on lime sulphur sprayed trees. The experiment was continued again this year at the farms of Mr. M. Udell, Grimsby, and of Mr. Wm. Corcoran, Port Dalhousie. The shucks spray was applied on June 15, and the maggot spray on June 25. Results are given in the following table.

BORDEAUX VS. LIME SULPHUR IN SOUR CHERRIES

	Average wt. per 1000 cherries		Six trees, crop given in 6 qt. baskets	Average diam. per cherry in 1-32 inch.
	lb.	oz.		
Lime sulphur.....	7	11	19½	23.5
Bordeaux 3-6-40.....	7	8	14½	23.1
Difference.....		3	5½	.4

The trees which were selected for this experiment had only a small crop this year. Consequently the cherries are larger than those of the previous year, averaging 23.3 thirty-seconds of an inch compared to 21.3 last year. With the trees bearing only a small crop, it was not expected that there would be much difference in size between those cherries sprayed with lime sulphur and those sprayed with Bordeaux. This experiment will be continued another year.

* See p. 102, end of section, for these literature references.

BROWN ROT

Field surveys made in 1925 and 1926 showed that blossom blight was present in all peach orchards of the Niagara district to a greater or less extent. Blossoms are infected when they are in full bloom and are killed by the brown rot organism. The infection spreads to the blossom pedicel and to the twig supporting it. On the twig small cankers are formed which may persist for several years, and which may work their way backwards to larger branches (plate 9, fig. 1). Twigs usually die from the point of infection outward, while on the branches, the cankers enlarge from year to year gradually weakening the stem, until it breaks at that point. The brown rot organism, through blossom blight, is apparently the primary cause of a large percentage of peach cankers. The average prevalence of blossom blight in 1925 was from 1 to 3 per cent, while in 1926 it was less than 2 per cent.

In the spring of 1925 some four hundred brown rot blighted blossoms were marked for observations. On June 15, twig cankers had formed in practically every case. That is, the brown rot organism had grown down from the blossom into the pedicel, twig, or branch supporting it. These cankers increased gradually during the growing season of 1925, from $\frac{1}{8}$ inch to $\frac{1}{4}$ inch in length, to $\frac{3}{4}$ inch to 1 inch by June 23, and in August many of the cankers were $1\frac{1}{2}$ inch to $2\frac{1}{2}$ inch long. These cankers were found on branches anywhere from $\frac{3}{16}$ inch to $2\frac{3}{4}$ inch in diameter. A survey made in August showed the following:—

(1) About 10 per cent of the cankers had dried up and healed over, and the fungus therein appeared to have died.

(2) Forty-seven per cent of the twigs on which the cankers had formed were dead from the canker to the tip of the twig, as a result of the girdling of the twig or branch by the brown rot fungus.

(3) The remainder of the cankers were still active, and the brown rot organism was repeatedly isolated therefrom.

In the spring of 1926 another survey was made of these cankers, but, due to a misunderstanding on the part of the grower where the experiment was under way, a large percentage of the cankers had been cut away during pruning operations. However a close examination of the cankers remaining showed that, although many had dried up and healthy callus had overgrown the area, still many others were actively enlarging, and the brown rot fructifications were readily noticeable with a hand lens. Isolations made from such cankers during the early summer of 1926 gave pure culture of *Sclerotinia cinerea* in the greatest number of cases.

Isolations made from one and two-year-old cankers of peach yielded the brown rot organism in 40 per cent of the cases. Isolations were made both from the pith and xylem of the twigs. The monilia stage of the brown rot organism was commonly found in nature on the surface of young cankers toward the end of May 1926. In moist chambers, cankers one or two years old produced the monilia stage abundantly in 40 per cent of the cases. It is apparent that the brown rot fungus winters over in young cankers, which provide a source for blossom blight and other infections for next year. Isolations made from plum and apricot cankers yielded brown rot in only a small percentage of the trials, while no isolations were secured from cherry twigs. Peach cankers more than two years old yielded brown rot in moist chambers only in one case, while *Valsa leucostoma* was quite common on these older cankers.

Brown rot apothecia were found in nature from the middle to the end of May. Apothecia were found growing from fallen fruits of peach, plum, and

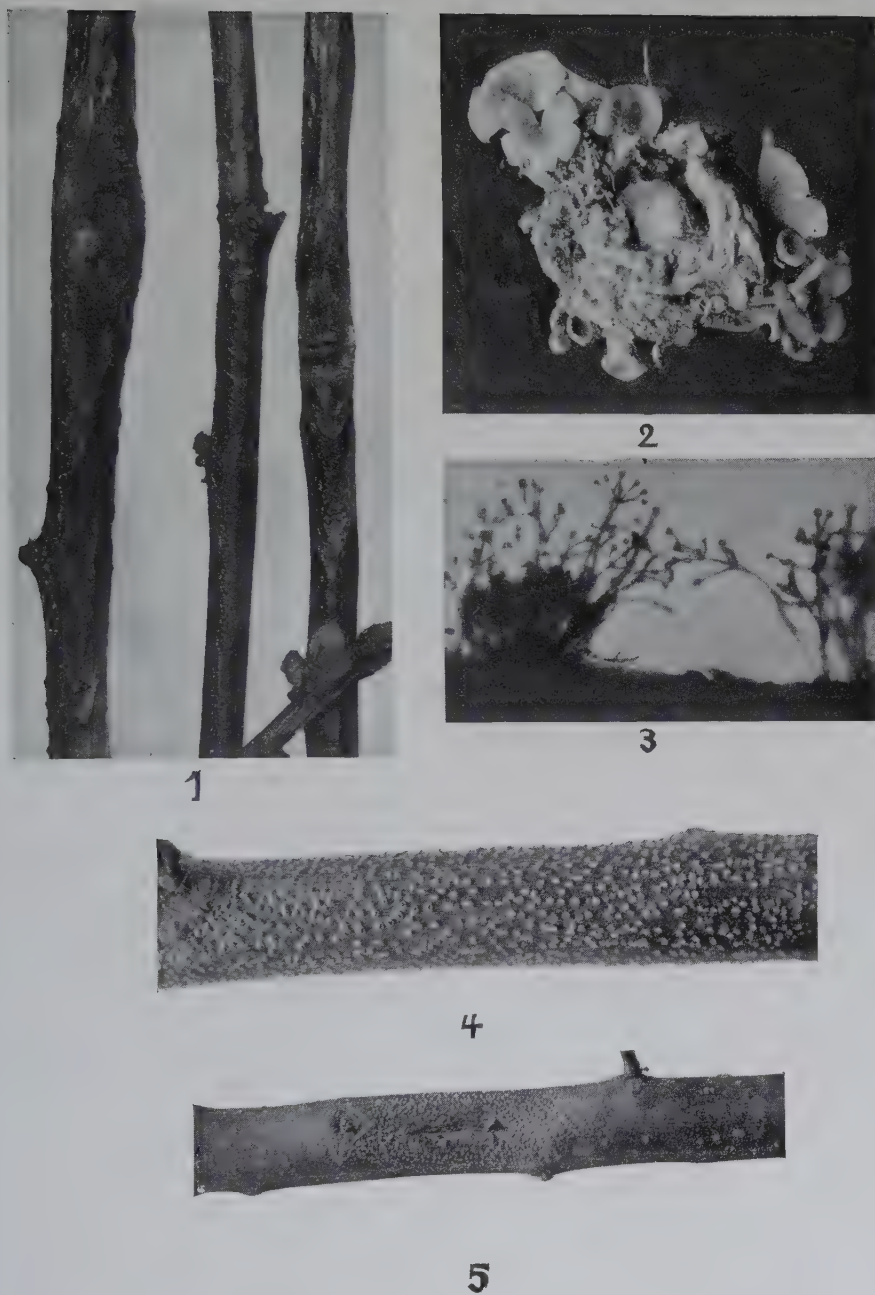


PLATE 9

- Fig. 1.—Blossom blight of peach, causing twig cankers.
 Fig. 2.—Apothecia from fallen Windsor cherries.
 Fig. 3.—Verticillium wilt fungus (type 66) of red and black raspberries.
 Fig. 4.—Fruiting bodies of *Fusicoccum* cankers of walnuts.
 Fig. 5.—Artificial canker produced by inoculating four-year-old English walnut tree with *Fusicoccum* sp. isolated from walnut

sweet cherry. This is believed to be the first recorded occurrence of apothecia on sweet cherry in Canada (plate 9, fig. 2). In Bulletin 1252, United States Department of Agriculture, apothecia from cherry are reported for the first time in the United States. Monosporic ascospore and conidial cultures were obtained from peach and cherry apothecia on the one hand, and from cankers, rotted fruits, blighted blossoms on the other. These strains were compared microscopically and macroscopically to determine if they might be separated on morphological grounds, but were found to be identical. The conidia in all cases averaged $8.5\ \mu$ by $12\ \mu$ in size.

There appears to be, therefore, no doubt but that blossom blight of peaches in the Niagara Peninsula is a source of primary infection and spread of the brown rot disease each spring. In addition considerable loss of crop results from the destruction of the twigs and small branches, due to die-back resulting from the girdling action of the canker formations. Also a considerable percentage of these cankers apparently continue to enlarge and grow, resulting in the large, destructive "peach cankers" so common in this district.

Growers are, therefore, advised to make an application of the dry-mixture spray or sulphur dust in the early blossom stage, in order to prevent blossom blight, which so often results in twig die-back, canker formations, and initial spore production and spread in the following spring.

RASPBERRY MOSAIC AND CERTIFIED RASPBERRY STOCK

The raspberry inspection and certification service was continued again this year in a similar manner as in former years. As a result of this service, some 60 acres of certified stock are now available. This represents an increase of 15 acres over last year's acreage. This stock comes from plantations which were carefully inspected twice during the growing season and which, at no time, showed as much as 1 per cent mosaic or leaf curl. In fact a good percentage of plantations were entirely free from mosaic and leaf curl.

The inspection service maintained by this laboratory was not confined to the Niagara peninsula but, upon request from the growers themselves, inspections were made in Hastings, York, Middlesex, Elgin, Brant, Wentworth, Haldimand, Halton, Ontario, Peel, and Norfolk counties. Close to five hundred visits were made for the purpose of raspberry inspection. From the visits of the raspberry inspectors, not only have some 60 acres of certified stock been made available, but also hundreds of growers have become cognizant of the symptoms of mosaic and leaf curl, and have been advised as to the best method of controlling these diseases under their particular conditions. Aid was also given in many cases with the actual roguing of the growers' plantation.

Surveys have again demonstrated the advisability of using healthy stock (certified stock) for planting purposes. Plantations set out with certified stock are much healthier and superior in all respects to those set out with ordinary stock. The demand for certified stock promises to be very good again this year, as several inquiries from New York State have been received, and one large order of 100,000 plants, from an Ontario grower, has already been received by one of the growers of certified stock. Several new growers have been added to our list and are showing interest in the production of disease-free stock. In this connection it is interesting to note the following report on Ontario certified stock set out in New York State.

" CERTIFIED STOCK IN NEW YORK STATE

" In 1924 and 1925 some 18,150 canes of Ontario certified stock were purchased by the growers of Monroe County, New York, through the Farm Bureau at Rochester. In the spring of 1926, Mr. R. C. Coombs, of this Bureau, who inspected the stock in 1925 and in 1926, very kindly sent the following report:—

" One lot of 4,150 plants showed 17 diseased plants in the fall of 1926.

" One lot of 14,000 plants showed 76 diseased plants in the fall of 1926."

It is very encouraging to find the Ontario stock standing up so well under New York conditions.

Mosaic was as usual found to be quite widespread and general, and in many cases it is seriously affecting the yield. In other cases, where the soil is especially favourable for raspberries, and where careful attention is given to fertilization, cultivation, etc., the reduction due to mosaic appears to be slight.

It is interesting to note that in Ontario, Cuthbert, Marlboro, and Herbert are the three most important commercial varieties with Cuthbert and Marlboro being about equally susceptible; while Herbert is generally found to be healthy, or infected to a very slight extent indeed.

As seen from the following report of inspections made in Quebec by Mr. Homère Racicot, of the Dominion Laboratory of Plant Pathology at St. Anne de la Pocatière, Newman 23 appears to be the most generally grown variety in Quebec, and it is susceptible to mosaic to about the same degree as Cuthbert. The Herbert apparently is just as healthy in Quebec as it is in Ontario.

TABLE 16

Number of inspection	Variety	Per cent Mosaic
1.....	Newman 23	4
2.....	Newman 23	19
3.....	Newman 23	60
4.....	Newman 23	2
5.....	Newman 23	32
6.....	Newman 23	22
7.....	Newman 23	25
8.....	Newman 23	5
9.....	Newman 23	2
10.....	Newman 23	15
11.....	Newman 23	trace
12.....	Newman 23	12
13.....	Newman 23	2
14.....	Newman 23	22
15.....	Newman 23	5
16.....	Newman 23	17
17.....	Newman 23	30
18.....	Newman 23	42
19.....	Newman 23	8
20.....	Newman	30
21.....	Newman 24	none
22.....	Herbert	"
23.....	Herbert	"
24.....	Herbert	"
25.....	Herbert	"
26.....	Herbert	"
27.....	King	100
28.....	Golden Queen	100
29.....	Unknown	24
30.....	Unknown	50
31.....		

PRODUCTION OF MOSAIC RASPBERRY BUSHES.—The following data give the results obtained from the second year's picking of an experimental plot of healthy and diseased bushes:—

TABLE 17

Date of picking	Healthy		Diseased	
	Wt. in oz.	No. of berries	Wt. in oz.	No. of berries
July 24.....	1	18	5½	108
July 29.....	24	306	49	705
July 31.....	40	556	60	962
Aug. 3.....	162	2,360	146	2,361
Aug. 5.....	184½	3,001	167	3,050
Aug. 10.....	200½	4,090	160½	3,666
Aug. 13.....	142	3,074	124½	2,931
Aug. 17.....	163	3,701	108	2,694
Aug. 20.....	70½	1,754	47½	1,250
Aug. 24.....	54½	1,543	36½	1,117
Aug. 27.....	16	557	8½	263
Total.....	1,058	20,960	913¼	19,107

The healthy plot produced 20,960 berries or 1,058 ounces, whereas the mosaic plot produced 19,107 berries or 913¼ ounces, a difference of 1,853 berries or 144 ounces, or about 6 quarts.

The reduction in yield due to mosaic was not so marked this year as last, and this is no doubt due, in part, to the fact that the total production of the healthy plot this year was only 85.3 per cent of that of 1925, whereas the production of the diseased plot this year was 97.6 per cent. In other words the mosaic plot produced practically the same crop as last year (within 2.4 per cent), while, on the other hand, the healthy plot did not produce nearly as large a crop this year, since it was 14.7 per cent less than last year's crop. This simply means that the factor or factors, that so decreased the crop from the healthy plot this year, did not to the same degree affect the mosaic plot.

In the spring of 1925 an experimental plot of healthy and mosaic bushes was set out for a study in comparison of yields. The first crop was picked in 1926, and the following table gives the results.

TABLE 18.—PRODUCTION OF HEALTHY AND MOSAIC CUTHBERT RASPBERRY BUSHES

Date	40 healthy plants		40 diseased plants	
	No. of berries	Quantity	No. of berries	Quantity
		qt.		qt.
July 27.....	668	1¾	781	1½
July 29.....	470	1½	467	1¼
Aug. 2.....	2,049	6½	2,178	6¼
Aug. 6.....	2,466	7½	2,666	7½
Aug. 10.....	2,043	5	1,861	4
Aug. 14.....	1,478	3½	1,499	3
Aug. 18.....	1,367	3½	1,484	3
Aug. 23.....	402	1	217	½
Total.....	10,943	29½	11,153	26½

There were, therefore, 210 more berries produced from the diseased plants than from the healthy plants, but the quantity of berries was two and two-thirds quarts less than from the healthy plants. The berries from diseased plants were, therefore, smaller in size and tended to be more crumbly.

The figures represent the total production of forty healthy and forty mosaic diseased plants. It was not expected that there would be much difference in

yield in the first crop, particularly since these bushes had been well manured, fertilized, and cultivated. However, even in the first year stunting of mosaic bushes was quite general and pronounced.

In the variety production plots a comparison of the yield of various varieties of raspberries was made. The figures are based on the production of fifty, two-year-old plants for the season. For certain varieties the production of an equal number of mosaic plants is also given.

TABLE 19.—VARIETY PRODUCTION PLOTS

Variety	Healthy		Diseased	
	No. of berries	Quantity	No. of berries	Quantity
		qts.		qts.
Herbert.....	10,545	32		
Marlboro.....	5,940	15	1,755	6 $\frac{1}{4}$
Adams 87.....	12,550	45 $\frac{1}{2}$		
Cayuga.....	9,005	22 $\frac{1}{2}$	4,243	15 $\frac{1}{4}$
St. Regis.....	2,875	8		
Seneca.....	5,560	15 $\frac{1}{2}$	6,200	15 $\frac{1}{2}$
Viking.....	9,838	30 $\frac{1}{2}$		
King.....	3,735	9 $\frac{1}{2}$		

It is interesting to note, under the seasonal conditions of 1926, that Marlboro and Cayuga show a decided reduction in crop due to mosaic, whereas Seneca is very little affected. It is also interesting to note that Adams 87 and Herbert varieties head the list, in so far as crop production from healthy bushes is concerned.

A second experimental plot in which the production of certain varieties was compared showed the following results. There was no mosaic whatever in these plots.

TABLE 20.—VARIETY PRODUCTION

Date of picking	Herbert		Cuthbert		Count	
	No. of berries	Quarts	No. of berries	Quarts	No. of berries	Quarts
July 27.....	4,437	12 $\frac{1}{2}$	6,610	16	2,437	4 $\frac{1}{2}$
July 30.....	5,683	18			1,539	4 $\frac{1}{2}$
Aug. 2.....	7,682	23	8,362	26	1,967	6
Aug. 5.....	8,135	25 $\frac{1}{2}$	6,132	19	1,353	3
Aug. 9.....	6,975	20	5,580	15	1,453	3 $\frac{1}{2}$
Aug. 13.....	5,244	13	3,841	9 $\frac{1}{2}$	946	2 $\frac{1}{2}$
Aug. 18.....	2,387	5 $\frac{3}{4}$	1,505	3	202	$\frac{1}{2}$
Aug. 23.....	1,150	2 $\frac{3}{4}$	253	$\frac{2}{3}$	115	$\frac{1}{3}$
Total.....	41,693	120 $\frac{10}{12}$	32,283	88 $\frac{9}{10}$	10,012	24 $\frac{1}{2}$

Date of picking	Brighton		Owasco		Cayuga	
	No. of berries	Quarts	No. of berries	Quarts	No. of berries	Quarts
July 27.....	4,656	12	846	2 $\frac{1}{4}$	783	2 $\frac{1}{2}$
July 30-31.....	1,400	3 $\frac{1}{2}$	340	1	507	1 $\frac{1}{2}$
Aug. 2.....	1,920	5 $\frac{1}{2}$	680	2	498	2
Aug. 2-6.....	2,010	5	477	1 $\frac{1}{3}$	360	1
Aug. 9.....	1,310	3	255	$\frac{2}{3}$	190	$\frac{1}{2}$
Aug. 13.....	1,268	3	94	$\frac{1}{4}$	54	$\frac{1}{4}$
Aug. 18.....	365	$\frac{3}{4}$	34		10	
Aug. 23.....	140	$\frac{1}{4}$	12			
Total.....	13,069	33	2,738	7 $\frac{1}{2}$	2,402	7 $\frac{1}{2}$

The production based upon fifty plants of each variety is as follows:—

	Berries	Quarts
(1) Herbert.....	21,490	62
(2) Cuthbert.....	19,215	53
(3) Count.....	13,905	33½
(4) Brighton.....	14,205	35½
(5) Owasco.....	11,405	31½
(6) Cayuga.....	7,060	22

FERTILIZATION EXPERIMENT.—A small two-year-old plantation of the Cuthbert variety has been prepared for tests with various fertilizers. This has been divided into five equal plots of thirty bushes each, twenty of which are mosaic. It is hoped hereby to get some definite information as to the value of the various fertilizers as an aid to overcoming the growth-inhibiting effect of mosaic. In the spring of 1926 the first application was made as follows:—

Plot 1.—Manure at the rate of 8 tons per acre.

Plot 2.—Nitrate of soda at the rate of 225 pounds per acre.

Plot 3.—Potash at the rate of 200 pounds per acre.

Plot 4.—Acid phosphate at the rate of 400 pounds per acre.

Plot 5.—Bone meal at the rate of 270 pounds per acre.

No appreciable difference in growth has as yet been noticed. Two additional applications will be made in 1927, one in the spring and the other in the fall.

CONTROL OF MOSAIC.—In the control of mosaic it is absolutely essential (1) to start with clean, healthy, certified stock, and (2) to keep it in this condition as long as possible by regular inspection and roguing of diseased bushes that creep in. That this can be done satisfactorily and economically has been demonstrated repeatedly by the purchasers of certified stock themselves, and by the experimental plots maintained by this laboratory.

We regret to report this year that the variety Adams 87 has taken mosaic to a slight extent. In a single experiment when aphids (*Amphorophora Rubi*) were transferred from mosaic Cuthbert to eight bushes of healthy Adams 87 on July 15, examination made on September 9, showed that four out of the eight inoculated plants had slight but characteristic symptoms of "mosaic." However, it is interesting to note that in no case has Adams 87 become naturally infected. In the experimental plots where mosaic plants of the Cuthbert and Viking varieties were planted in the same hill along with healthy Adams 87, in 1924, as yet in no single case has Adams 87 become diseased. Although our inoculation experiments have shown that Adams 87 may take the mosaic disease, yet the variety may, like the Herbert, be highly resistant to the disease, in that it largely escapes infection because, most likely, the juices of these varieties are not relished by the aphids as a source of food.

A new circular on Raspberry Mosaic, Leaf Curl, Rosette, and Wilt, pamphlet 72, has just been published, and is now available for distribution. Copies of this may be obtained by writing to the Publications Branch, Ottawa, or to the Dominion Laboratory of Plant Pathology, St. Catharines, Ontario.

LEAF CURL

Leaf curl was found to be somewhat more prevalent this season than it has been for the last three years. However, growers who know this disease and who practise rigid roguing are able to effectively keep the diseases under control. Pamphlet 72, recently off the press, describes this disease in more detail. This will be sent to any one upon request.

RASPBERRY WILT

Raspberry wilt caused by *Verticillium ovatum*, B. & J. was not so general or severe this year as it has been the last two seasons. A paper on this disease was published in Scientific Agriculture, Vol. VI, No. 8, 1926, and this disease is also dealt with in the new circular mentioned above, namely pamphlet 72, "Studies in Raspberry Diseases," which can be obtained direct from this laboratory, or from the Publications Branch, Department of Agriculture, Ottawa.

In an attempt to obtain information relating to the control of this disease, the following preliminary demonstration was carried out on the farm of Mr. Wm. Corcoran, Port Dalhousie.

No. of plants	Wilted plants treated as follows	Date	Wilted Oct. 12	Healthy Oct. 12
2	Partially rogued.....	July 15	.....	2
6	Rogued and reset.....	"	2	4
8	Pruned.....	"	3	5
4	Untouched.....	"	3	1

Partially rogued means that only that part of the plant which showed signs of wilt was rogued.

Rogued and reset, means that the entire plant was rogued, and a new plant immediately set in its place.

Pruned means that the wilted plant was cut off at the surface of the ground.

It is our intention to try this same experiment in 1927, but on a much larger scale, if we can find a satisfactory plantation in which to carry out the experiment.

STRAWBERRY DISEASES

In last year's annual report mention was made of definite mosaic-like symptoms found on the Eaton variety of strawberry. These symptoms were very pronounced, and resembled the usual mosaic symptom, with mottling, stunting, and dwarfing of the plants, and puckering or curling of the leaf tissue. In the spring of 1925 over one hundred of these mottled plants were set out in an experimental plot at St. Catharines. In the spring of 1926 all the plants set out, as well as all runners formed therefrom, showed the same mottling as formerly, and stunting and dwarfing were present to a greater or less extent. In 1925 the mosaic-like symptoms almost entirely disappeared with the coming of warm climatic conditions in July and August. And yet these same plants and their runners, showed the same mosaic-like symptoms in the spring of 1926. And again, with the advent of warm weather conditions in 1926, the symptoms largely disappeared.

Some two hundred inoculations were effected by transferring of juice from the diseased plants to healthy plants by way of aphid transfer, rubbing of leaf tissue, and the pin point method. As yet no definite consistent results have been obtained. In a few cases stunting of the inoculated plant was apparent, but no mottling has as yet appeared. However, since it is a characteristic of this trouble, that the mottling disappears in late summer and fall, the failure of the appearance of mottling in these inoculated plants is to be expected. Further observations and inoculations will be continued in 1927.

A preliminary survey of strawberry plantations during 1926 showed diseased conditions to be general throughout Ontario, and in many cases to be very severe. There is urgent need of special attention being given to strawberry troubles, since strawberry growers are finding these diseases to be on the increase. It is our intention, if pressure of other work is not too great, to have one of the staff give his entire time to strawberry diseases in 1927.

Fusicoccum SP. ON WALNUT

In the fall of 1925 three English walnut trees on the farm of Wm. Corcoran showed diseased conditions on several branches, in the form of darkened, slightly depressed cankers. These limbs were of course devoid of leaves. During the winter and early spring of 1926 these cankers continued to grow, so that by spring they were much more definite and were literally covered with mature and immature pycnidia (plate 9, fig. 4.). The margin between the healthy and diseased wood was fairly sharply defined, due to the dark coloration of the diseased wood. Isolations were made from many of these diseased branches, both from pieces of the diseased wood, and from the spores produced in the pycnidia. Cultures of *Fusarium* sp. and *Fusicoccum* sp. were obtained in most cases, the *Fusicoccum* being more general and corresponding to the pycnidia formed in the cankers. Inoculations were then made on June 21st by placing pieces of the *Fusicoccum* culture in small slits made in the smaller branches.

On June 22 a second series of inoculations was made, using the *Fusarium* sp. isolated. Up to December 9 no positive results were obtained from the inoculations with *Fusarium*. With the *Fusicoccum* inoculations, however, the bark surrounding the point of inoculation became blackened, and, on July 29 when further observations were made, it was found that a *Fusicoccum* canker had formed around the point of inoculation, and pycnidia were scattered plentifully over the entire canker (plate 9, fig. 5.). Re-isolations were made from these artificial cankers, and pure cultures of *Fusicoccum* were obtained. When this *Fusicoccum* sp. is grown in potato dextrose agar, pycnidia are often very plentiful. We have, therefore, come to the conclusion that the disease as found on English walnut on the farm of Mr. Wm. Corcoran is caused by a *Fusicoccum* sp. In 1927 a survey of English walnut trees will be made to ascertain if this disease is present elsewhere in the Niagara peninsula. After cultures of the walnut *Fusicoccum* had produced pycnidia, spores from these were used for a second series of inoculations on August 9, 1926. On September 15 three of these inoculations showed the characteristic, slightly sunken, black, canker-like, diseased areas that were first observed in the fall of 1925. Up until the present, however, no pycnidia have formed.

DESCRIPTION OF FUNGUS.—Cultures of the fungus on potato agar medium are covered with a grayish, aerial mycelium 1.5-3 mm. high, the surface of which is arachnoid, irregular, or choppy. Pycnidia arise from the surface of the medium usually in clusters, 3-5 mm. high. Pycnidia are hard; walled; osteoleum; cavity of several irregular chambers, or simple.

Substratum dark brownish.

Conidia hyaline, continuous, of two forms in the same cavity: (1) subfusoid, $5-8\mu \times 1.5-2.5\mu$, av. $6.5\mu \times 2\mu$, (2) long, slender (scoleospores) $10-17\mu \times 1-1.5\mu$, av. $13\mu \times 1\mu$.

DEAD ARM OF GRAPES

(By L. C. Coleman)

An investigation of the disease known as the dead arm of grapes was begun in June, 1926. This disease is widespread throughout the grape-growing areas of the Niagara peninsula and, according to the opinion of many growers, is increasing in seriousness and importance. The disease as it occurs in New York state has already been investigated by Reddick, who published two bulletins on the subject, the first in 1909, and the second in 1914. Reddick described the causal organism in his first bulletin as *Fusicoccum viticolum*, but Shear in 1911 showed that the fungus has an ascus-bearing stage, which brings it into the genus *Cryptosporella*. The name of the casual fungus is, therefore, *Cryptosporella viticola*.

The striking symptoms in the field are the stunting and curling down of the leaves, and the yellowing of the foliage on arms showing the disease. These symptoms are most strikingly apparent in June and early July. Later the yellow colour changes to green, and the leaves, while still remaining somewhat stunted and curled, become less conspicuously so. These symptoms precede the death of the arm, which may occur during the same growing season, but which usually occurs during the following winter (plate 10, fig. 1).

Associated with these striking symptoms were found, as a feature not hitherto made clear, necrotic lesions on the stem, at times far removed from the affected arm, but always embracing that segment of the vascular system which feeds it. These lesions usually bear on their surface the pycnidia, or spore-bearing organs, of the causative agent (plate 10, fig. 3). The lesions were invariably found to be associated with a pruned stub or an arm which had been sawed off, and this seemed to indicate that the organism gains its entrance to the host through the pruning wounds. Inoculations with spore suspensions from pure cultures on fresh pruning wounds, or wounds that had been left two weeks to dry, produced infection in practically every case. As these inoculations were made in late July and early August, the progress of the disease from these inoculations will have to be studied next year. In any case, a study of the lesions shows that the disease progresses slowly at first, and probably takes from five to six years in most cases to produce the typical symptoms on the arms. A study of apparently healthy vines in affected vineyards showed lesions in many cases. Similarly, many cases of so-called chlorosis were found to be associated with lesions produced by the dead arm fungus. There was little if any evidence of fungous infestation on the affected arms themselves and, in this respect, the observations are different from those reported by Reddick.

This preliminary investigation shows clearly that the removal of the affected arms as a combative measure is useless, for the seat of the disease is to be found, in the great majority of cases at least, in a lesion or lesions on the stem much lower down. However, these lesions are not difficult to locate if one follows down from the affected arm, removing the dead bark to facilitate inspection. The difficulty comes where no typical symptoms are present. Even in this case a general appearance of unthriftness in an arm should lead to suspicion and to inspection. Similarly cases of chlorosis should be examined for lesions. All parts above the lowest lesion should be removed.

If, as seems now probable, infection occurs mainly through pruning wounds, the spraying or brushing of these wounds with a fungicide in the early spring seems a possible remedy. The disinfection of pruning tools at the time of removal for dead arm in June, and the painting of the pruned surface with white lead to prevent fresh infection, are also precautionary measures which should be taken.

DEAD ARM AND CHLOROSIS

From observations made for two seasons at Barnesdale and Vineland graperies, it appears that most of the grape vines showing the so-called chlorosis have necrotic areas on the trunk or limbs, and that these vines later develop definite dead arm symptoms. Of twenty-one vines, which in 1925 showed chlorosis, fourteen in 1926 showed definite dead arm symptoms. In 1926 twenty-seven vines showing chlorosis were examined, and necrotic areas were found on twenty-one of the vines.

In this connection it is interesting to note the results obtained from the grapery of Mr. D. Crole, St. Catharines, in which applications of ferrous and magnesium sulphate were applied to chlorotic vines.

In 1925, of fifteen chlorotic vines treated, eleven showed signs of improvement. This improvement was based solely on the state of the foliage in late summer and fall; vines, which had yellowish dwarfed leaves in spring but



PLATE 10.—“DEAD ARM” DISEASE OF GRAPE VINES

- Fig. 1.—Appearance of diseased grape vine.
 Fig. 2.—Cross section through diseased stem.
 Fig. 3.—Typical lesion caused by disease.
 Fig. 4.—Numerous fruiting bodies of fungus causing “Dead arm.”

(Photos: Coleman—Toronto)

which overcame this condition and produced (in comparison with check vines) normal green leaves by fall, were considered to be on the highway to recovery. No examination was made at this time for necrotic areas on trunk or limb. However, in 1926 when examination was made for necrotic areas on trunk and limb, it was found that nine of the eleven vines showed the presence of the typical necrotic areas associated with the dead arm disease. Three of the vines were, however, still healthy, and have completely recovered from their chlorotic condition of 1924.

It would seem, therefore, that, although the majority of so-called chlorotic vines may be incipient symptoms of the dead arm disease, as noted above, yet there appears to be another chlorotic condition of grape vines, which shows no necrotic areas whatever, and which, under certain conditions, favourably responds to treatment with iron sulphate. The three vines, which apparently recovered in 1925, were still healthy in the fall of 1926, and showed no signs whatever of necrotic areas. In other graperies examined, sixteen vines out of forty-eight examined showed chlorotic condition with no necrotic areas whatever. There is, of course, the possibility that a chlorotic condition may become apparent in a vine, due to the presence of the dead arm fungus, before necrotic areas of any size have had time to develop.

The observations recorded here on chlorosis throw some light on the divergent results that have been obtained from the use of ferrous and magnesium salts on so-called chlorotic vines. If chlorotic vines have necrotic areas on trunk or limbs, it is, of course, apparent that application of salts alone is not going to have any lasting effect towards recovery.

BLACK HEART OF APRICOT

In the spring of 1926 many cases of twig blight of apricot were reported to this laboratory. Upon examination it was found that small cankers were present on some of the twigs and small branches below the blighted area. Generally these showed fructifications of the brown rot organism, and from such cankers the brown rot organism was readily isolated from internal pieces of the wood. In other cases no cankers or fungous fructifications were apparent, and cross sections of these diseased branches showed a black heart. Isolations from such diseased branches gave a species of *Verticillium*, along with other forms of fungi. Repeated isolations gave *Verticillium* about 50 per cent of the time. Cross sections of the black heart area showed the presence of abundant mycelium in the wood elements. Pure cultures of this *Verticillium* were obtained by planting in petri dishes, and inoculations were made in small branches of an apricot tree on August 7. On October 10 one of the branches, which had been inoculated in two places, showed yellow wilting foliage, and by the 19th, the branch had become defoliated. This particular branch was brought into the laboratory for examination, and it was found that the fungus had travelled for a distance of about 1 inch from the point of inoculation, as demonstrated by the darkening of the wood for some little distance around each point of inoculation. Isolations were then made from the darkened areas resulting from inoculation, and cultures of a *Verticillium* sp., similar to those used for inoculation, were obtained. It, therefore, appears that this particular type of apricot wilt in Ontario is caused by a species of *Verticillium*, and, so far as I am aware, this is the first time that this disease has been reported in Canada. In 1923 Helen Czarnecki described the black heart disease of apricot in California, and demonstrated that a species of *Verticillium* was the cause. Her description of the disease and the fungus causing it agrees very closely with the disease herewith reported for the first time in Canada.

The disease first manifests itself by a slight yellowing and wilting of the leaves at the tip of a branch. The wilting then progresses backward from the tip until the whole branch is affected. Following yellowing and wilting, the leaves fall. If a branch which has lost its leaves is cut into, it is seen that the heart is discoloured a dark brown to black colour.

As stated above, we have shown that this disease is caused by a species of *Verticillium* of which the following is a description on potato agar.

THE FUNGUS.—In two days a white, aerial, mycelial culture is produced, and conidia and verticillate conidiophores begin to form on the 3rd, or 4th day. Conidia are also produced in abundance from the tips of side branches of the ordinary mycelium. In five to six days chlamydospores and microsclerotia begin to form and, later, the surface of the medium is often covered with a black sclerotial crust. Aerial mycelium is still present as a covering over the black sclerotial tissue, but with age this often collapses, with the result that the black sclerotial crust becomes more prominent, and gives the culture a continuous black appearance.

The mycelium is hyaline, septate, surface-loving to aerial, profusely branched. Conidiophores verticillately branched, $20\ \mu$ to $275\ \mu$ in length, bearing conidia, $6.1\text{--}11.0\ \mu \times 2.25\text{--}4.9\ \mu$, in heads. Conidia are also found at tips of side branches of the regular vegetative mycelium.

At the present time we are not in a position to describe this form in more detail, as we have only had it in culture a short time. However, the formation of sclerotia places the form in the *Verticillium Dahliae* group. Study of this disease and the fungus causing it will be continued in 1927.

Miss Czarnecki has the following to say in connection with control.

PROBABLE CONTROL.—The probable method of control will be tree surgery, by immediately cutting out wilted branches, if it proves possible to cut below affected areas, or else by removing the entire tree in the fall, in order to prevent spore infection the following year, from the fruiting bodies on the dead twigs of affected branches.

STUDIES IN TOMATO STREAK

During the fall of 1924 and the spring of 1925, several severe outbreaks of tomato streak occurred in greenhouses at Vineland, Ontario. In one particular case the crop was practically a complete loss. This laboratory, therefore, became interested in a preliminary study of this disease, in so far as time would permit. We are especially indebted to Mr. Merle Fretz, Vineland, for his co-operation and kindness in lending the use of his commercial greenhouses for experimental purposes.

The first part of these studies has to do with observations made in many greenhouses and with experiments in connection with control of streak. The second part deals with experiments in connection with more fundamental aspects such as causes, varieties affected, inoculation experiments, etc.

PART I

1. In greenhouse A, which is one of a range of four, during the last two years streak has been present to a considerable extent, and has been most severe always in the southeast section of the house. The first cases were invariably found there, from whence it then seems to have spread to three-quarters of the greenhouse. In other words here is an observation that suggests a connection with the soil, and which points to a fairly rapid spread of the disease.

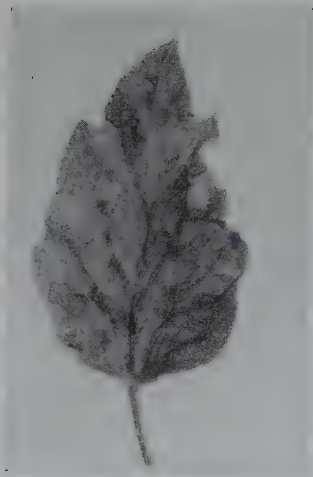
In greenhouse B, streak appeared here and there throughout the greenhouse (19 plants), with three the greatest number together at any one place. In this case streak did not spread to more than five additional plants. This case appears to be quite different from the above. In A there appears to have been one point from which spread started, while in B there were many centres of possible spread. Yet in B there was practically no spread, while in A the spread was considerable. There is no doubt but that, in so far as spread is concerned, greenhouse environment plays a very important rôle.

2. From observations made during the last three crops in the greenhouses at Vineland there appear to be two kinds of streak in so far as symptoms are concerned, or, perhaps more correctly, the necrotic areas of streak may be of two types. No attempt has as yet been made to verify this by inoculation and cross inoculations. However, in the west greenhouse of Mr. Merle Fretz, Vineland, most of the "streaked" plants were of the normal type, with black necrotic areas on stem, leaves and sometimes fruit (plate 11, fig. 1). Under favourable conditions these plants usually become partially or wholly defoliated, stunted, and practically worthless. In this same greenhouse there have been (in the last two crops) a half dozen or more plants which showed necrotic areas on leaves and fruit, but in so far as the leaves were concerned, the necrotic areas were not black in colour, but rather greyish-white (plate 11, fig. 2). The tomato plants having this type of necrosis never became affected to the same degree as the previously described type. In fact the necrotic areas did not spread over the leaf surface to any extent, with the result that the leaves very seldom dried up and died. Whether these are two distinct types, or the apparent difference in symptoms is merely a difference in degree of the same type, remains yet to be ascertained.

3. Although in nearly all cases of streak, mosaic symptoms are likewise present, as a mottling of the tip foliage at least, I have observed some half dozen plants at different times, growing alongside normal "streak" plants, which showed no signs whatever of mosaic mottling before or after the streak lesions appeared. This is an interesting observation. The lack of mosaic symptoms can hardly be explained in these cases on the basis of temperature-masking, since, under the same growing conditions and at the same time, other streak plants showed the mosaic symptoms.

4. It has been shown by Howitt & Stone and others, that soft, succulent growth is a predisposing factor with this disease. The first endeavour, from the standpoint of prevention, was, therefore, to attempt to have an even, regular growth, so as to avoid a too rapid growth at one stage, with its resultant soft, succulent tissue, followed by a necessary checking up of the growth rate at a later period. It was also desired to have the plants free from mosaic, as the work of Gardner⁴ and, later, Vanterpool⁵ has shown that streak is a virus disease. To this end the seed was sterilized, fresh soil was used, and the plants were grown in one of the greenhouses in plots as far away from mosaic plants as possible. It would have been preferable if these could have been grown in a greenhouse or cold frame distant from all solanaceous crops, but at this time it was impossible. However the plants were very healthy, the percentage of mosaic plants being much less than Mr. Fretz had formerly had. Before transplanting the plants into the greenhouse, the soil was completely turned over to about 18 to 20 inches depth, and a heavy application of manure worked in. The soil was therefore fairly rich.

Mr. Fretz so manipulated ventilation, water, and heat, that as steady a growth as possible might result. No nitrate was added, but, when the plants were forming the second truss, a light mulch was added to the soil. Another mulch was added three weeks later. In so far as possible, the temperature was kept around 70° F. in the day time, and not below 50° F. at night. The result



1



2



3

PLATE 11.—STREAK DISEASE INVESTIGATIONS

Fig. 1.—Tomato leaf showing black necrotic areas of streak.

Fig. 2.—Tomato leaf showing greyish-white necrotic areas of streak.

Fig. 3.—Left: A necrotic shoot killed shortly after appearing above ground. Right: A "speckled mosaic" shoot. Both these shoots (see Exp. 13) came from tobacco plants which had been previously killed by tomato streak, but which later sent up the shoots, as illustrated, from below ground portions of the crown. The "speckled mosaic" grew very rapidly for a time, as can be seen by the photograph, but in time it also became necrotic and died.

was that the plants grew very evenly, steadily, yet fairly rapidly, and the resulting crop was the best that Mr. Fretz ever had. In this greenhouse not one case of streak showed up. In this greenhouse some thirty-five plants were inoculated with streak material by means of pin pricks, rubbing of leaves, and insertion of macerated streak tissue in slits in the stem. *In no single case did streak result.* These plants were growing fairly rapidly at the time, and were forming the 3rd and 4th trusses.

Why did streak not appear in this greenhouse? Why did not some cases appear as a result of inoculation, especially since the writer on many other occasions has had 100 per cent infection of healthy tomato plants by inoculations with streak material? Are the negative results to be put down to greenhouse management? It hardly seems possible, and yet later 100 per cent positive results were obtained from inoculation with the streak material from the same source.

In the other greenhouse some twenty-five streaked plants showed up but the spread was nil, due to the careful methods of pruning and pollinating used by Mr. Fretz.

In this connection it was desirable to obtain information concerning the following points relating to control. Once a plant has become streaked, is it advisable to (1) dig it out? (2) add fertilizer and moisture to increase its growth rate, and attempt to grow it out of the disease, or (3) to try and gradually slow up the growth and harden the plant?

Twenty-four tomato plants were inoculated with streak, and were then treated as follows:—

On October 11, all plants were inoculated.

Experiment 1

Six plants received a heavy application of manure water the day they were inoculated (October 11), and this was repeated on two other occasions, the 13th, and 18th respectively. These same plants received two heavy applications of nitrate of soda, so much so that they showed signs of wilting.

On October 21, all six plants showed definite and severe streak, so much so that, on the 24th, the plants were useless and were "dug up." This experiment, therefore, bears out the findings of Howitt & Stone³ that too liberal applications of nitrate and nitrogenous manures are to be avoided.

Experiment 2

Six other plants were inoculated and left untouched. These showed streak symptoms on October 24, but not so severe as in the previous case. This, of course, again bears out the fact that plants which are abnormally forced suffer most severely from this disease. These six plants were likewise dug up in order to see if this would keep down spread. It was found that three plants in the adjacent row contracted the disease. It did not spread further.

It is interesting to note that the second six plants were three days longer in showing the streak symptoms, than the first. The nitrogenous manures, therefore, not only brought on a much more severe type of streak, but also shortened the incubation period by three days.

The other twelve plants were scattered throughout the greenhouse. These streak plants were very carefully handled; the pruning was done in such a manner that no juice came in contact with the hand at any time. This was effected by holding the shoot to be pruned about one inch from the desired point of severance and then, by giving it a quick pull, the shoot was broken off cleanly with no contact whatever with the cut surface. By being careful, therefore, with pruning and pollinating, in only three cases did the disease spread to the neighbouring plant.

In order to ascertain whether or not streak may be spread by the grower during pruning operations, especially when pinching off shoots from "streaked" plants, and then passing directly to pinching off shoots from healthy plants, Mr. Merle Fretz very kindly consented to start in at plant No. 1 in the southeast corner and then to systematically take each plant in order. In so doing Mr. Fretz passed directly from twenty-five "streak" plants to the same number of healthy plants, and yet in no single case did streak spread.

However, the writer has seen other cases here and elsewhere where definite spread did occur from pruning operations.

From experience with tomato streak at Mr. Merle Fretz's greenhouses, it would seem that streak as a disease need not be severe, if healthy plants are set out in the first place, and growth thereafter is maintained at a fairly steady pace. Temperature as near 70° F. as possible, with strict adherence to regularity in watering, lessening or increasing the amount according to weather conditions, appear to be important. The application of acid phosphate is also to be recommended. The soil should be rich to start with, so that there is little need of adding mulch, or nitrogenous fertilizers. Great care should be taken to start in the first place with healthy plants, and to avoid any practice that is apt to spread the streak disease, once it has made its appearance.

PART 2

There are to-day three views held as to the etiology of streak.

(1) That it is caused by bacteria.

Paine & Bewley⁶, 1919, published an account of experiments which showed that *Bacillus Lathyri*, Mans & Taubenhaus was the cause of a disease of tomato in England, which had symptoms identical with streak. Howitt & Stone, Dickson, others, and the writer have all isolated yellow bacteria agreeing with the description of *Bacillus Lathyri*, but in no case have positive results been obtained from inoculation.

(2) That it is a virus disease, a type of mosaic.

In Vol. 30 of Jour. Agr. Res. No. 9, page 871, 1925, Max W. Gardner⁴ considers severe streak of Bonny Best to be a mosaic disease, and further says, "the mosaic nature of the disease was further verified by successful inoculation of healthy tomato seedlings with the juice of a young fruit by J. B. Kendrick, and by numerous cultural tests, which proved the internal fruit lesions to be free from bacteria." So far as the writer is aware this is the first definite record of a verification of the mosaic nature of streak.

(3) That it is non-parasitic, and is the result of malnutrition and improper environmental conditions in the greenhouse.

In Phytopathology, May 1926, Vanterpool published a paper on streak of tomato in Quebec in which he verifies Gardner⁴ in that the "streak" disease of tomatoes is of the "filterable virus" type. He, however, goes further and says, "that all evidence indicates that these combined viruses (potato mosaic and tomato mosaic) are the true causes of the trouble." Recently James Johnson⁷ has pointed out that juice of healthy potato combined with tobacco mosaic produced an extremely malignant type of disease with necrosis on various members of the solanaceous family. On the tomato it is often so virulent as to kill the entire plant. He has also demonstrated that the juices from healthy potato alone (especially Rural New Yorker) produce mosaic symptoms on tobacco with necrotic areas in many cases, (streak).

The following experiments were projected by the author in the greenhouses of (1) Mr. Merle Fretz, Vineland, (2) the laboratory greenhouse, and (3) in field experiments at various places throughout the district. The details of these experiments will not be given, since it is considered that all due precaution was used in the transfers, etc. Inoculations were generally effected by needle punctures, or direct insertion of macerated tissue.

Experiment 1

To verify the findings of Gardner & Vanterpool that streak is a virus disease the following inoculations were carried out in the greenhouse of Mr. Merle Fretz, Vineland.

TABLE 21

No. of plants	Method of inoculation	Source of inoculum	Mosaic
10	Rubbing of tip leaves.....	Tomato, Streak A.....	
10	Insertion of macerated leaf tissue.....	Tomato, Streak A.....	10
10	Insertion of macerated leaf tissue.....	Lower leaves (apparently healthy) of streak.....	10
10	Insertion of macerated leaf tissue and leaf rubbing.....	Tomato mosaic shoestring type.....	10
10	Insertion in stem of macerated leaf tissue.....	Tomato, Streak B.....	
5	.....	Tomato mosaic and streak.....	5
500	Check plants.....	.....	450

Since the five hundred check plants all became more or less mottled toward the end of the experiment, the mosaic symptoms occurring on the inoculated plants were not likely the direct result of inoculations. No streak symptoms whatever occurred.

Experiment 2

Further inoculations were tried out in the greenhouse of Mr. Wm. Fretz, as follows:—

TABLE 22

No. of plants	Method of inoculation	Source of inoculum	Streak	Mosaic	No positive results
6	Insertion.....	Streak material A.....	6		
9	Insertion.....	Streak B.....	6	2	1
3	Rubbing.....	Streak B.....	3		
100	Check plants.....	.....	.....	.....	.....

NOTE.—Streak material A was obtained from the greenhouse of Mr. Merle Fretz, while streak material B was from that of Mr. J. D. Fretz.

Experiment 3

On July 30, 1926, there were inoculated, by rubbing, twelve tomato plants that were growing outdoors, and were making very poor growth, and were accordingly not in a soft, succulent state.

TABLE 23

No. of plants	Source of inoculum	Streak	Remarks
5	Lower (healthy?) leaves of streak plant.....	3	Yellow and definite mosaic 2.
5	Definite streaked leaves.....	3	2 mosaic.
3	Check plants.....	1	2 healthy.

Experiment 4

The following experiments were carried out in the Laboratory greenhouse and land at St. Catharines. Ten healthy tomato plants about ten inches high, outdoors, were inoculated with filtered juice and macerated tissue of streaked material, as follows:—

TABLE 24

Plant No.	Streak inoculum	Date of inoculation	Results
3	Filtered juice.....	June 22	Streak July 15.
3	Macerated tissue.....	June 22	Streak July 15.
4	Pulp.....	June 22	Streak July 15.
9	Check plants.....		All showed signs of mosaic by July 8th, but no streak.

Experiment 5

To ascertain if all parts of a plant carry the infective principle the following experiment was carried out. Inoculations were effected by insertion of macerated tissue in stem.

TABLE 25

Date	No. of plants	Material for inoculum	Date streak appeared	In-cubation period	Per cent streak
Aug. 4....	10*	Crushed leaves.....	Aug. 16	12 days	100
Aug. 4....	10*	Stems, petioles.....	Aug. 19	15 days	100
Aug. 4....	20*	Roots macerated.....	Aug. 19	15 days	100

*NOTE:—Plants when inoculated were about to mature their first fruit, and were, therefore, of considerable size. It is interesting to note, therefore, that in every case streak first appeared on the fruit four or five days, at least, before appearing on stem or leaves. In some cases the fruit alone was affected.

The experiments outlined are a good example of the inconsistencies which the writer has encountered at various times with streak inoculation experiments. In experiment 1, not one case resulted from fifty-five inoculations. Yet in four other experiments practically one hundred per cent positive results were obtained from streak inoculations. In other cases the writer has had positive results from inoculating healthy tomato plants with tomato mosaic alone, and even with juice from healthy tomato plants, as well as potato, and yet at other times negative results were obtained. In all cases the inoculations were effected in the same manner, and in some instances with the same material. The writer does not attempt as yet to explain such inconsistencies.

Experiment 6

The following experiment was projected to ascertain if there is any particular stage in the growth of a tomato plant when it is more susceptible to streak than at another time. This experiment was tried out under both greenhouse and field conditions at St. Catharines. The seedlings were set out at the same time and made a fairly rapid growth. When they were about nine to ten inches high the first series of inoculations were effected, and then at intervals of seven days the second, third, etc., series of inoculations were carried out, so that there was a difference of four weeks' growth between the first and last inoculations. The height of the plants in inches is given at time of inoculation, and when streak first appeared.

TABLE 26

Plants	No.	Inoculation		Streak first appeared		In-cubation period	Per cent streak
		Date	Height	Date	Height		
			inches		inches	days	
5.....	1	Aug. 25	9	Sept. 5	12	11	100
	2	" 25	9	" 5	13	11	
	3	" 25	8	" 5	13	11	
	4	" 25	6	" 5	11.5	11	
	5	" 25	9	" 15	25	21	
5.....	1	Sept. 1	11	Sept. 14	18	13	100
	2	" 1	14	" 13	19	12	
	3	" 1	13	" 13	18	12	
	4	" 1	11	" 20	17	19	
	5	" 1	15	" 16	22	25	
5.....	1	Sept. 8	19	Sept. 20	24	12	100
	2	" 8	18	" 18	26	10	
	3	" 8	22	" 22	30	14	
	4	" 8	23	" 20	31	12	
	5	" 8	20	" 20	28	12	
5.....	1	Sept. 15	23	Sept. 27	37	12	100
	2	" 15	22	" 27	35	12	
	3	" 15	27	" 27	39	12	
	4	" 15	24	" 27	32	12	
5.....	1	Sept. 29	32	Oct. 6	33	7	100
	2	" 29	38	" 13	42	14	
	3	" 29	33	" 13	34	14	
	4	" 29	38	" 17	44	18	

Four plants were left as check and remained healthy during the time of the experiment.

Experiment 7

This same experiment was tried out with tomatoes growing under field conditions.

TABLE 27

No. of plants	Inoculations		Streak first appeared		In-cubation period	Per cent streak		
	Date	Height	Date	Height				
		inches		inches	days			
1.....	Aug. 28	8	Sept. 9	9	12	100		
2.....	" 28	7	" 9	9	12			
3.....	" 28	8	" 9	10	12			
4.....	" 28	8	" 9	7	12			
1.....	Sept. 3	8	Sept. 20	11	17	100		
2.....	" 3	9	" 15	11	12			
3.....	" 3	8	" 15	9	12			
4.....	" 3	8.5	" 20	10	17			
1.....	Sept. 9	9.5	Sept. 27	11	18	100		
2.....	" 9	10	" 27	13	18			
3.....	" 9	10	" 20	11	11			
4.....	" 9	9	" 27	11	18			
1.....	Sept. 15	11	Sept. 30	21	15	100		
2.....	" 15	12			" 30		21	15
3.....	" 15	14			" 29		12	14
4.....	" 15	11						
5.....	Check plants.....		healthy at end of experiment					

The results in the greenhouse do not entirely correspond to those obtained in the field. In the greenhouse where the plants were growing rapidly, the incubation period averaged around twelve to thirteen days, while in the field it averaged fifteen to sixteen days. In the greenhouse the incubation period was about the same, irrespective of the age of the plant, whereas in the field, the age of the plant appears to have had an appreciable effect on the incubation period, as manifested by an incubation period of around twelve days in the case of the younger plants and a period of eighteen to twenty days in the case of the older plants. It is appreciated, of course, that the varying climatic conditions in the field influenced these results.

Experiment 8

The following six commercial varieties were grown in the greenhouse at St. Catharines and tested for susceptibility to streak.

TABLE 28

No. of plants	Date of inoculation	Date streak appeared	Incubation period	Variety of tomato
			days	
1.....	Sept. 8	Sept. 22	14	Sunrise.
2.....	" 8	" 24	16	"
3.....	" 8	" 20	12	"
1.....	Sept. 8	Sept. 20	12	Chalks Jewel.
2.....	" 8	" 24	16	"
3.....	" 8	" 22	14	"
1.....	Sept. 8	Sept. 20	12	Earliana.
2.....	" 8	" 20	12	"
3.....	" 8	" 22	14	"
1.....	Sept. 8	Sept. 22	14	Bonny Best.
2.....	" 8	" 22	14	"
3.....	" 8	" 22	14	"
1.....	Sept. 8	Sept. 20	12	New Globe.
2.....	" 8	" 20	12	"
3.....	" 8	" 20	12	"
1.....	Sept. 8	Sept. 20	12	Grand Rapids.
2.....	" 8	" 24	16	"
3.....	" 8	" 24	16	"

All varieties tested took streak with equal readiness, although the Earliana and Globe varieties showed symptoms slightly more severe than the other varieties. Also streak appeared on these varieties slightly in advance of the other varieties.

A similar experiment was tested out under field conditions with identical results.

Experiment 9

The following experiment was carried out to ascertain the effect of inoculating healthy tomato plants of the Bonny Best variety with juice from healthy tomato plants of the same and other varieties, as well as healthy tobacco and potato juices.

TABLE 29

No. of plants	Inoculum	Date of inoculation	Appearance of mottling	Appearance of streak	In-cubation period	Remarks
					days	
1.....	Bonny Best.....	Sept. 8	Sept. 21	Sept. 27	19	Foliage of yellow colour.
2.....	"	" 8	"	"	"	
3.....	"	" 8	Sept. 22	Sept. 27	19	
1.....	Globe.....	Sept. 8				Healthy.
2.....	"	" 8	Sept. 22	Sept. 24	16	
3.....	"	" 8	" 22	" 24	16	
1.....	Sunrise.....	Sept. 8	Sept. 22			Mosaic.
2.....	"	" 8	" 27			"
3.....	"	" 8	" 27			"
1.....	Chalks Jewel.....	Sept. 8	Sept. 24			Foliage slightly yellowish, with definite curling of tip leaves and coarse yellowish green blotching.
2.....	"	" 8	" 24			
3.....	"	" 8	" 24			
1.....	Tobacco.....	Sept. 8	Sept. 20			Mosaic.
2.....	"	" 8	" 22			"
3.....	"	" 8	" 24			"
1.....	Potato.....	Sept. 8				
2.....	"	" 8	Sept. 22	Sept. 24	16	
3.....	"	" 8	" 24	" 27	19	
4.....	"	Dec. 6		Dec. 17	11	
5.....	"	" 6		" 18	12	
6.....	"	" 6		" 18	12	

It is very interesting to note that streak was obtained in some cases by inoculating healthy tomato plants with juice from apparently healthy tomato plants. Streak was obtained when juice from Bonny Best and Globe varieties of tomatoes was used for inoculum. No streak was obtained when juice from healthy plants of Sunrise or Chalks Jewel was used as inoculum, although in one case (Sunrise) definite mosaic symptoms were obtained, and in the other (Chalks Jewel) a very peculiar yellowish green blotching was obtained.

These results, however, are somewhat inconclusive, since the plants were unprotected and, therefore, these inoculations should be tried again under more controlled conditions and in greater numbers. However, it is interesting to note that all the plants were inoculated on the same day, September 8, and that the streak symptoms began to show up at about the same time throughout the house, namely September 24-27. This would appear to indicate that natural infection did not take place. In order to verify Experiment 9, in so far as healthy potato juice is concerned twelve healthy tomato plants that were protected from the time the seed was sown till after the experiment was completed, were inoculated under controlled conditions with fifty per cent positive results. In other words, on three different occasions, under varying greenhouse environment, streak has resulted from inoculating healthy tomato plants with the juice of healthy potato plants.

Such experimental evidence warrants the conclusion that the juice from potato, whether healthy, as this term now implies, or whether affected with mosaic or streak diseases, incites the streak disease in healthy tomatoes. This may mean that the potato plant naturally carries a latent virus, or else that it has in its juices (protoplasm) something that initiates or excites in the protoplasm of the tomato plant an abnormal metabolism that produces the characteristic "streak" symptoms. There is, therefore, no necessity of postulating a

combination of viruses (potato mosaic and tomato mosaic) as the real cause of streak (5), since potato juice itself is sufficient to cause streak, as has been demonstrated here.

Experiment 10

The following is an experiment to ascertain the effect when healthy tomato plants are inoculated with juice from mosaic tomato, mosaic tobacco, and mosaic potato plants, singly and in combination. The tomato plants to be inoculated were protected by insect-proof cages in order that no undesirable inoculation might take place. These cages were not removed until the end of the experiment.

TABLE 30

No. of plants	Inoculum	Date of inoculation	Date streak showed	Incubation period
1	Tomato mosaic.....	Sept. 14	Sept. 24	10
2	".....	" 14	" 24	10
3	".....	" 14	" 24	10
1	{ Tomato mosaic and }.....	" 14	" 22	8
2	{ Potato mosaic and }.....	" 14	" 24	10
3	{ Tomato mosaic and }.....	" 14	" 24	10
1	Potato mosaic.....	" 9	" 22	13
2	".....	" 9	" 22	13
3	".....	" 9	" 22	13
1	{ Tobacco mosaic and }.....	" 14	" 24	10
2	{ Tomato mosaic and }.....	" 14	" 24	10
3	{ Tobacco mosaic and }.....	" 14	" 22	8
1	Tobacco mosaic.....	" 9	" 22	13
2	".....	" 9	" 26	17
3	".....	" 9	" 27	18
5	Check plants remained healthy.			

The results, as indicated here, would seem to point out that in addition to potato juices, mosaic tomato and mosaic tobacco juices would likewise cause streak, particularly when this experiment was carried out under controlled conditions. However, another similar experiment under similar controlled conditions, from the time the seed was sown until the experiment was completed, has given negative results with mosaic tomato, and mosaic tobacco juices. At the present time, therefore, these results are inconclusive, and need further experimentation.

The writer, of course, realizes that the material used for inoculum, although coming from apparently mosaic plants, may have had latent streak virus present, but, if so, the streak symptoms were entirely absent. Moreover the tomato, potato, and tobacco plants from which the leaves for inoculating were taken, had up to November 1, no signs whatever of streak.

Experiment 11

This same experiment was tried out in the Fretz commercial greenhouse at Vineland, and outdoors at St. Catharines, Ontario, but the plants were not caged.

TABLE 31

No. of plants	Inoculum	Date of inoculation	Results
6	Potato mosaic.	Oct. 11	6 plants streak on Oct. 22. The source of inoculum in this case was taken from a field of potatoes 50 per cent mosaic.
6	Tobacco mosaic.	" 11	6 plants mosaic.
6	Potato streak.	" 11	6 plants streak on Oct. 22.
6	Potato streak.	" 11	6 plants streak on Oct. 22.
6	Potato mosaic.	" 11	2 plants streak. 5 plants mosaic and stunted.
6	Potato and tomato mosaics.	" 11	3 plants streak on Oct. 25. 3 plants mosaic.
6	Potato streak.	" 11	6 plants streak on Oct. 24.

It is interesting to note that, where either tomato streak or potato streak were used singly as source of inoculum, 100 per cent infection was obtained in eleven days. But where potato streak and tomato mosaic in combination were used as sources of inoculum, 50 per cent infection only was obtained, and was delayed three days in showing up. This time negative results were obtained with tomato mosaic (with exception of two plants) and tobacco mosaic.

One hundred check plants all showed definite mosaic mottling at the end of the experiment, so that the showing up of mosaic symptoms on the inoculated plants was not likely due to the inoculations. No streak whatever showed up in the one hundred check plants.

Experiment 12

In the following experiment healthy plants were set outdoors for inoculating as follows, and over one hundred check plants (healthy) of the same origin were healthy at end of the experiment.

TABLE 32

Variety	No. of plants	Inoculum	Date of inoculation	Streak appeared	Mosaic	In-cubation period
Grand Rapids.....	1	Tobacco mosaic.	Sept. 14	.....	Mosaic.	
	2	.....	" 14	.....	"
	3	.....	" 14	.....	"
	4	.....	" 14	Sept. 30	.....	16
Grand Rapids.....	1	Potato mosaic.	" 14	" 27	.....	13
	2	.....	" 14	" 27	.....	16
	3	.....	" 14	" 30	.....	16
	4	.....	" 14	" 27	.....	13
	1	Tomato & potato mosaics	" 14	" 27	.....	13
	2	.....	" 14	" 24	.....	10
	3	.....	" 14	" 27	.....	13
	3	.....	" 14	" 27	.....	13
Grand Rapids.....	1	Tobacco & tomato mosaics	" 14	.....	Mosaic	
	2	.....	" 14	.....	"
	3	.....	" 14	.....	"
	4	.....	" 14	.....	"
Grand Rapids.....	1	Tomato mosaic.	" 14	Sept. 27	.....	13
	2	.....	" 14	" 27	.....	13
	3	.....	" 14	" 30	.....	13
	4	.....	" 14	" 30	.....	16
Grand Rapids.....	100	Check plants.....	.....	.....	Healthy.	

It is interesting to note again that streak resulted from potato mosaic (singly), as well as from potato mosaic and tomato mosaic in combination. Also that no streak resulted in the case of inoculation with tobacco and tomato mosaics in combination. Streak likewise resulted from inoculating Grand Rapids with tomato mosaic (Veal variety).

Experiment 13

TABLE 33.—INOCULATED HEALTHY TOBACCO PLANTS WITH JUICE FROM STREAK TOMATO PLANTS
(Twenty-five healthy tobacco plants were used as a check.)

No. of plants	Date of inoculation	Date of appearance of mosaic and necrotic areas	Percentage of infection	Results with symptoms
8	Sept. 8	Sept. 20-24	75%*	From 12 to 14 days after inoculation mosaic symptoms with black necrotic areas were present on leaf blade and petiole. This was followed by complete break down, drying up, and dying of the affected leaves.
25	Uninoculated.	.....	.....	The check plants in all cases remained healthy throughout the experiment.

*NOTE.—It is very interesting to note that two of the tobacco plants which died down as a result of being inoculated with *tomato streak*, sent up new shoots from below the ground line. In one case this new shoot in turn became necrotic and died within a few days. In the other case the shoot was "speckled mosaic" (plate 11, fig. 3.) from the very start. This shoot continued to grow for about two weeks when over night it showed several necrotic areas on stem, petiole, and leaf blades, and soon dried up and died. This points out the possibility of apparently mosaic plants, carrying a latent "streak" virus.

Inoculating healthy tobacco plants with tomato "streak" produced on the tobacco plant necrotic "areas" similar to the necrotic areas on streak tomato plants (plate 12, figs. 1 and 2). This type of injury with necrotic areas on tobacco will be spoken of as tobacco "streak". That is, both tomato and tobacco plants have mosaic mottlings without necrotic areas, and apparently both may have necrotic areas associated with mosaic symptoms. On tomato such symptoms have been designated "streak". It, therefore, seems justifiable to likewise designate such symptoms on tobacco as "streak" of tobacco. In the case of tobacco the necrotic areas of streak generally occur first along the midrib and main veins (plate 12, figs. 1, 2 and 3). This, no doubt, accounts for the rapid drying out and dying of such affected leaves.

Is it possible to transfer tobacco streak back to tomato again?

Experiment 14

TABLE 34.—INOCULATED HEALTHY TOMATO PLANTS WITH TOBACCO STREAK, RESULTANT FROM INOCULATING TOBACCO PLANTS WITH TOMATO STREAK

No. of plants inoculated	Inoculum	Date of inoculation	Tomato streak	Percentage of infection	Results
6: 2 in greenhouse. 4 on platform of greenhouse, but outdoors.	Tobacco streak.	Sept. 24	Oct. 4-6	100	All tomato plants showed the characteristic streak symptoms as a result of the inoculation.
6.....	Uninoculated	.....	.....	.....	All were healthy at end of the experiment.



PLATE 12

Fig. 1.—Tobacco leaf showing necrotic areas along mid-rib, main veins, and on leaf blade tissue.

Fig. 2.—Tobacco plant inoculated with tomato streak, showing several necrotic and dried up leaves in centre of crown.

Fig. 3.—Tobacco leaf showing necrotic areas along main vein, and leaf blade tissue.

Fig. 4.—Left: Plant killed by tomato streak. Middle: Plant partially killed by tomato streak. Right: Healthy plant.

This, therefore, demonstrates that tomato streak is transferable to tobacco where it causes a necrosis, similar in many respects to that on tomato (plate 12, fig. 4). It is also possible to transfer streak back again to tomato from tobacco. Transfers were also made from tobacco to tobacco with positive results in about fifty per cent of the cases.

Experiments outlined above also demonstrate that potato streak is transferable to tomato, and from tomato to tomato. It would seem, therefore, that the causal agency in both cases might be the same. However, until more is known of the properties of the juices in question, this interpretation is open to objection because, although the host range is the same, it does not necessarily follow that the viruses are identical.

Experiment 15

TABLE 35.—INOCULATED HEALTHY TOBACCO PLANTS AS FOLLOWS
(Date of inoculation.....October 10.)

No. of plants inoculated	Source of inoculum	Results of inoculation on		
		October 20	October 26	November 2
5.....	Potato mosaic.....	1. Healthy	Healthy	Healthy
		2. Healthy	Mosaic	Mosaic
		3. Healthy	Healthy	Healthy
		4. Healthy	Streak. N.*	Streak. N.
		5. Streak. N.	Streak. N.	Streak. N.
6.....	Tomato streak.....	1. Mosaic	Mosaic	Streak
		2. Healthy	Mosaic	Streak
		3. Healthy	Mosaic	Streak
		4. Mosaic	Streak	Streak
		5. Streak. N.	Streak. N.	Streak. N.
		6. Streak. N.	Streak. N.	Streak. N.
5.....	Tobacco streak.....	1. Mosaic	Mosaic	Streak
		2. Stunted	Streak	Streak
		3. Mosaic	Streak	Streak
		4. Healthy	Healthy	Healthy
		5. Healthy	Healthy	Healthy

*NOTE.—N.—Indicates plants whose leaves rapidly became necrotic, dried up, and plant as a whole died.

DISCUSSION

The experimental evidence submitted here is believed to be sufficient to warrant the following conclusions:—

(1) That “streak” may be produced in tomato plants by inoculating healthy plants with the following juices:—

- (a) Healthy potato juice.
- (b) Mosaic potato juice.

Johnson (7) states that “most potato varieties uniformly possess the property of inducing a disease in tobacco and *other solanaceous plants* which is infectious in nature and belongs to the class of filterable “viruses”. This ability is present regardless of whether the potato is healthy, as this word is generally applied, or affected with one or another of the common virus diseases of the potato.” What Johnson has said for potato juice in connection with tobacco, the present evidence bears out for the tomato. It is not necessary to have a combination of potato and tomato viruses, as stated by Vanterpool (5), in order to obtain streak, since the potato juice itself will produce this effect.

- (c) Tomato streak juice.
- (d) Tobacco streak juice.
- (e) Potato streak juice.

In Vanterpool's (5) recent publication on "Tomato Streak in Quebec", he says, "the writer has been unable to produce streak in tomato from potato streak alone". He did produce streak in tomato by using potato streak and tomato mosaic in combination. The present writer, however, has obtained on several occasions one hundred per cent infection with potato streak alone.

2. That streak (necrosis) may be produced in tobacco by inoculating healthy tobacco with:—

- (a) Tomato streak.
- (b) Tobacco streak.

Vanterpool (5) was unable to produce necrotic areas on tobacco by inoculations with tomato streak, but obtained thereby mosaic symptoms of a severe type, which, when inoculated into tomato plants, produced streak. The writer, however, more often obtained necrosis (streak) than mosaic, when tomato streak was inoculated into healthy tobacco. Streak in tomato likewise resulted when juice from such artificially produced tobacco streak was used as inoculum. As a possible explanation for the lack of necrotic areas in tobacco as reported by Vanterpool may be cited the case (experiment 13 above) where two tobacco plants, that had been inoculated with tomato streak, became necrotic and died. Both plants, however, sent up new shoots from below ground, one of which was necrotic as formerly, and the other was "speckled mosaic" (plate 11, fig. 3) for a period of two to three weeks, when it in turn became necrotic and died. From the history of this latter plant we know that it contained the streak "virus", yet under certain conditions it only showed mosaic symptoms.

It should be recalled that all plants, from which leaves were taken and used for inoculation purposes, were kept long after these experiments terminated, in some cases for over four months, and in no single case did any of these plants change in any way. That is, a mosaic plant remained mosaic, and did not show any signs of streak. A healthy plant remained healthy, etc.

Since definite streak on healthy tomatoes (necrotic areas) has resulted from the transference of healthy potato juice, or mosaic potato juice, it would seem that the theory of a combination of viruses (5) as the real cause of streak is incorrect. Supporting this contention is the recent publication of Johnson (7) in which he states he was able to induce mosaic symptoms with necrosis on tobacco by an inoculum with healthy potato juice.

Verticillium INVESTIGATIONS

Studies on the *Verticillium* problem in general, and on Raspberry Wilt caused by *Verticillium ovatum* B. & J., have been conducted by the St. Catharines Laboratory since 1923. Two papers were published during 1926 namely (1) "*Verticillium* Wilt of the Red Raspberry" in Scientific Agriculture, Vol. VI, No. 8, and (2) "Studies in Raspberry Diseases," Dominion of Canada, Department of Agriculture, pamphlet No. 72, New Series. These publications cover the work which has been done on Raspberry Wilt and on *Verticillium ovatum*. Results of our investigations on the general *Verticillium* problem are included here, and consist chiefly of cultural and taxonomic studies of many strains of *Verticillia*. The following list gives the host and place of origin of the thirty-two different strains under study.

TABLE 36—VERTICILLIUM ISOLATIONS

No. or letter	Host	Place of origin	Date of origin or date received
A.....	Red Raspberry.....	St. Catharines.....	Sept. 1923
B.....	Potato.....	Holland.....	1923
D.....	Dahlia.....	Holland.....	1923
V.....	Maple.....	Ottawa (McCallum).....	1923
W.....	Potato.....	".....	1923
C.....	Aster.....	St. Catharines (Cole).....	Sept. 1925
C ²	".....	".....	" 1925
E.....	Red Raspberry.....	" (Robertson).....	Aug. 1925
E ²	".....	".....	" 1925
K.....	Barberry.....	Toronto.....	Sept. 1925
M.....	Maple.....	Geneva (Rankin).....	1925
T.....	Tomato.....	".....	1925
R.....	Red Raspberry.....	".....	1925
R ²	".....	".....	1925
O.....	Potato.....	Northern Ont. (Tucker).....	Aug. 1925
O ²	".....	".....	" 1925
P.....	Tomato.....	Sheluiandah Ont. (Murray).....	Mar. 1926
P ²	".....	".....	" 1926
15 (5).....	Potato.....	Washington, D.C.....	Feb. 1926
40.....	Tomato.....	".....	" 1926
41 (80).....	Maple.....	".....	" 1926
50.....	Red Raspberry.....	St. Catharines (Wills).....	Aug. 1925
56.....	".....	".....	" 1925
57.....	".....	".....	" 1925
58.....	".....	England (Harris).....	Mar. 1926
59.....	Potato.....	Holland (Van der Meer).....	Apr. 1925
61.....	Sumach.....	Ithaca N. Y. (Barrus).....	Oct. 1924
62.....	Maple.....	".....	Sept. 1924
63.....	Peach.....	".....	" 1924
64.....	Peach.....	".....	Jan. 1925
65.....	Aralia.....	".....	Nov. 1925
66.....	Red Raspberry.....	St. Catharines.....	Sept. 1925

It was first attempted to classify the different strains of *Verticillium* into groups according to cultural characteristics. The two main groups of *Verticillium*, according to Van der Meer, are (1) *Dahliae* group; producing black microsclerotia and (2) *albo-atrum* group; producing dark mycelium. The following third group should probably be added: (3) *Verticillia* producing no black colour. The strains under study are grouped as follows:—

Group 1.—A, C, C², D, E, E², K, M, R, R², T, V, W, 50, 56, 57, 58, 61, 62, 63, 64, 65.

Group 2.—O, O², P, 59.

Group 3.—B, P², 15, 40, 66.

It was observed, in the case of many strains in Group 1, that short strands of dark mycelium were present. These, however, did not occur alone but were always connected with the microsclerotia,—usually as short projecting pieces. In Group 2, on the other hand long strands of black mycelium were present, without any evidence of the formation of microsclerotia.

CULTURE MEDIA

SOLID MEDIA

1. Potato dextrose agar.

300 gms. peeled potato; 30 gms. dextrose; agar 22 gms. 1,000 c.c. tap water. pH 5.85.

2. Peptone dextrose synthetic agar.

KH₂PO₄, 1gm.; MgSO₄, .25 gms.; FeSO₄, .05 gms.; peptone 30 gms.; dextrose 30, gms.; agar 25 gms.; distilled water 1,000 c.c.

3. Peptone lactose agar.

Similar to No. 2 excepting that lactose replaces dextrose.

4. Nitrate dextrose agar.

Similar to No. 2 excepting that sodium nitrate replaces peptone.

5. Prune agar.

150 gms. dried prunes; agar 40 gms.; 1,000 c.c. water.

LIQUID MEDIA

6. Potato dextrose broth.

As for No. 1 but without agar.

7. Peptone dextrose synthetic solution.

As for No. 2 but without agar.

CULTURAL CHARACTERISTICS.—Cultures of the different strains under study produced varying amounts of aerial mycelium. In some a dense white compact aerial growth was produced, which was usually of a smooth character but in two strains—15 and 66—the aerial mycelium grew in coremial tufts. Many strains produced only a loose, scanty, aerial growth, and others scarcely any at all. Strains, such as O and P, formed slimy cultures due to abundant sporulation including yeast-like budding. In such cultures the stroma is completely covered with the slimy masses of spores. Upon drying out these cultures are of a cheese-like consistency and with a wrinkled surface.

Conidia are produced singly at the tips of verticillately branched conidiophores, and are held together at the tips by moisture, as small droplets or beads. Conidia are also produced in the same manner by simple conidiophores, which may arise from almost any point of the mycelium. Certain strains, such as O and P, on almost all agars, and other strains on certain media, notably on nitrate dextrose agar produce conidia by budding. Budding may take place directly from segments of mycelium or from conidia. In the latter case a short pro-mycelium may or may not be produced.

Chlamydospores are produced in the stroma by many strains. These are in chains and clumps which later become black, and a cluster of such dark chlamydospores produces a microsclerotium. The production of microsclerotia varies in amount with different strains and different media. With some, such as A, V, 41, 61, etc., the entire stroma becomes a black crust, and there is scarcely any covering of aerial mycelium. With others as 65, T, etc., only a few scattered microsclerotia are present in the stroma after fourteen days, and these are only visible from the reverse side of the culture, since a copious aerial mycelium covers the top of the colony. Certain strains, such as 59, P, O, do not produce microsclerotia, but the older strands of mycelium turn black, and doubtless act as a resting stage. A few strains have produced no black of any kind in culture.

Single spore cultures were secured of many of the above forms, some of which have been in culture for over three years. These have remained remarkably constant, and subcultures have always been very uniform. This may be due partly to the fact that re-plating was done periodically, and this process kept the strains in a vigorous condition. In selecting an inoculum from a re-plate, the most vigorous and most typical colonies were always used.

In this process of re-plating colonies showed up in certain strains, which appeared to be different from the original. In this way, the strains C₂, P₂, O₂, R₂, 50, and 57 were secured from C, P, O, R, and 56 respectively. The new strains in every case were ones which produced less black and more aerial mycelium than the originals.

EXPLANATORY NOTES IN CONNECTION WITH DESCRIPTIONS

Stroma refers to the mycelial mat lying on the surface of the medium.

A.M. refers to aerial mycelium.

Guttation is the collection of small drops of clear or coloured liquid on the surface of a colony.

A slimy culture is one in which sporulation (mostly by yeast-like budding) is so abundant as to cover the stroma by slimy masses of spores.

DESCRIPTION OF THE STRAINS OF "VERTICILLIUM"

Strains A, C, E, R, V, 41, 56, 61, 62, 63, 64 = *Verticillium ovatum*.

Conidia average $2.25\text{--}2.5\mu \times 4.25\text{--}4.5\mu$

Solid Media

Potato dextrose agar.

Stroma—a black crust of microsclerotia, wrinkled; microsclerotia sometimes not developed at and just below the centre of the colony; slimy areas may be present.

A.M.—wanting, or occurring as small loose patches chiefly toward the centre of the colony.

Peptone dextrose agar.

Stroma—dark, wrinkled, microsclerotia fairly numerous.

A.M.—2 mm. high covering the stroma; white, smooth, compact; sometimes with pale bluff tint, and with guttation of small drops of clear liquid.

Peptone lactose agar.

Stroma—colony usually circular, and not covering the entire agar slant; a black crust of microsclerotia forms a broad circular band around centre, or the black crust may be more extensive; margin of surface-living mycelium.

A.M.—thin and loose, white.

Nitrate dextrose agar.

Stroma—black crust of microsclerotia forming ring around centre, or only partial ring in upper and lower parts of colony, or black crust may be more extensive; slimy areas usually present.

A.M.—very thin and loose, but often a denser tuft of white mycelium in the centre.

Prune agar.

Stroma—a black fairly smooth crust of microsclerotia.

A.M.—wanting or very thin.

Liquid Media

Potato dextrose broth.

Growth—good; loose mycelium at bottom and white wrinkled crust at top, black microsclerotia around margins, and to slight extent in the top crust.

A.M.—scarcely any.

Peptone dextrose solution.

Growth—good, same description as for growth on potato dextrose broth.

A.M.—scarcely any.

Strain D. = *Verticillium Dahliae*

Conidia av. $2.07\mu \times 4.63\mu$

On all media, except peptone dextrose agar, cultures of this strain are similar to those of *Verticillium ovatum*, except that there is always a greater production of white aerial mycelium in the case of *Verticillium Dahliae*, so that the cultures are always more completely covered with a loose aerial growth.

Peptone dextrose agar.

Stroma—brownish, wrinkled mat of mycelium more or less covered with slimy masses of spores; margin of surface-living mycelium.

A.M.—loose, white, most dense in centre.

Liquid Cultures

Descriptions similar to those of *Verticillium ovatum*.

Strain M. = *Verticillium* sp.

Conidia av. $1.9\mu \times 4.3\mu$

Potato dextrose agar.

Stroma—wrinkled; black microsclerotia at top and edges of colony, also crescent of black in top part of culture about 1 cm. from centre.

A.M.—loose, very shallow, powdery in appearance; parts of culture are moist and lack aerial mycelium.

Substratum—pale yellow in colour.

Peptone dextrose agar.

Stroma—wrinkled, no black.

A.M.—white, fairly compact, fair in amount, covering the stroma.

Peptone lactose agar.

Stroma—wrinkled, microsclerotia present chiefly at top part of culture.

A.M.—loose, very shallow, and powdery in appearance.

Nitrate dextrose agar.

Stroma—wrinkled, no black.

A.M.—fair in amount, white, smooth, compact.

Prune agar.

Stroma—wrinkled, microsclerotia giving black colour to most of the colony.

A.M.—poorly developed; loose, white; most of the colony is slimy and moist.

*Liquid Media***Potato dextrose broth.**

Growth—fair, loose mycelial web at bottom and top of culture; mycelial mat around margin at top. No microsclerotia.

A.M.—none present, colony moist.

Peptone dextrose solution.

Growth—good, loose mycelial wefts at bottom, and mycelial mat covering the top, and clinging to glass at margin; microsclerotia present to slight extent around margin.

A.M.—very shallow, loose, and powdery.

Strain 65 = *Verticillium* sp.

Conidia av. $2\mu \times 4.84\mu$

Potato dextrose agar.

Stroma—colourless.

A.M.—abundant, white, compact, cottony.

Peptone dextrose agar.

Stroma—colourless.

A.M.—abundant, compact, cottony, pale buff tinge, and guttation of few drops of clear liquid.

Peptone lactose agar.

Stroma—colourless.

A.M.—fairly abundant; compact, white to pale buff.

Nitrate dextrose agar.

Stroma—colourless.

A.M.—fairly abundant, white, collapsed in areas showing moist stroma.

Prune agar.

Stroma—microsclerotia present chiefly in upper parts of colony.

A.M.—fairly abundant, cottony white.

*Liquid Media***Potato dextrose broth.**

Growth—very good, mycelial mat covering surface of medium; no microsclerotia.

A.M.—well developed, white, cottony, smooth.

Peptone dextrose solution.

Same as previous medium.

Strains K and C₂ = *Verticillium* sp.

Conidia av. $2.1\mu \times 4.2-4.6\mu$

Potato dextrose agar.

Stroma—mostly a black crust of microsclerotia visible only from reverse side.
A.M.—well developed, covering the colony; white, compact, cottony.

Peptone dextrose agar.

Stroma—fairly abundant microsclerotia in top parts of colony.
A.M.—similar to that on potato dextrose agar.

Peptone lactose agar.

Stroma—microsclerotia present to slight extent in top parts of colony and along sides.
A.M.—fairly well developed, white, compact.

Nitrate dextrose agar.

Stroma—mostly a black crust of microsclerotia.
A.M.—well developed, but less abundant than on potato dextrose agar.

Prune agar.

Stroma—a black crust of microsclerotia covers the colony.
A.M.—fairly well developed, covering the colony, but loose, white, may be collapsed in areas.

Liquid Media

Potato dextrose broth.

Growth—only fair loose mycelial wefts at bottom and centre of top of culture, mycelial mat around margin of top; no microsclerotia.
A.M.—none; colony moist.

Peptone dextrose solution.

Growth—good mycelial mat covers top of culture clinging to glass at sides; few microsclerotia around margin.
A.M.—very shallow, loose, and powdery in appearance.

Strains E₂, R₂, 57 = *Verticillium* sp.

Conidia av. $2\mu \times 4\mu$

Solid Media

On solid media the cultures resemble those of the previous strains (K and C₂), except that in most cases the aerial mycelium is more copious.

Liquid Media

Potato dextrose agar.

Growth—good, culture covered with mycelial mat and also loose wefts of mycelium at the bottom; no microsclerotia.
A.M.—well developed, covering the mat; white, smooth, compact.

Peptone dextrose solution.

Similar to culture on potato dextrose agar, except that guttation of drops of amber-coloured liquid takes place over the surface.

Strains 50, 58, W, T. = *Verticillium* sp.

Conidia av. $2.75\mu \times 4.52\mu$

Potato dextrose agar.

Stroma—slightly wrinkled; microsclerotia few toward top of culture and along sides.
A.M.—abundant, white, cottony.

Peptone dextrose agar.

Stroma—no microsclerotia.
A.M.—abundant, slightly creamy, cottony, smooth surface.

Peptone lactose agar.

Stroma—microsclerotia few toward top of culture.
A.M.—good, slightly creamy, smooth surface.

Nitrate dextrose agar.

Stroma—slimy, but covered with aerial mycelium; few microsclerotia toward top of culture.

Prune agar.

Stroma—microsclerotia fairly abundant, giving black colour to reverse side of culture.
A.M.—fair growth, white, loose, cottony.

Liquid Media

Potato dextrose broth.

Growth—good, mycelial mat covers surface of medium, no microsclerotia.
A.M.—shallow but fairly compact, white.

Peptone dextrose solution.

Similar to that on potato dextrose broth.

Strain 59 = *Verticillium albo-atrum*.

Conidia $2.08\mu \times 4.42\mu$

Potato dextrose agar.

Stroma—wrinkled black, mycelial strands showing toward top of culture.

A.M.—abundant, white, cottony; may be collapsed and moist in certain small areas.

On the other agar media, cultures are very similar to that on potato dextrose agar. On peptone dextrose agar there is no black mycelium. The height of aerial mycelium on peptone dextrose agar is 5 mm., on peptone lactose agar 2 mm., nitrate dextrose agar $1\frac{1}{2}$ mm., and on prune agar 3 mm.

Liquid Media

Potato dextrose broth.

Growth—poor, loose mycelial wefts at bottom and on surface of liquid, and a ring around margin. No black.

A.M.—none, culture slimy.

Peptone dextrose solution.

Growth—good, loose mycelial colonies at bottom, and thick mycelial mat covering top.

Mycelium grows up side of glass for $1\frac{1}{2}$ cm. No black.

A.M.—none, or slight where mycelium clings to glass; culture slimy.

Strains P, O = *Verticillium* sp.

Conidia $2.2-2.5\mu \times 5\mu$

Potato dextrose agar.

Stroma—slimy; wrinkled; black mycelium abundant, especially in upper parts of the colony and along sides.

A.M.—very shallow, white to tinge of pale buff, powdery in appearance, small areas may be covered with a white, cottony mycelium.

Peptone dextrose agar.

Stroma—slimy, wrinkled, and no black mycelium.

A.M.—present, white to pale buff, cottony, usually covering the culture.

Peptone lactose agar.

Stroma—similar to that on potato dextrose agar, but less black mycelium.

A.M.—similar to that on peptone dextrose agar.

Nitrate dextrose agar.

Stroma—slimy, black mycelium in upper part chiefly.

A.M.—poorly developed, shallow, powdery, or wanting.

Prune agar.

Stroma—slimy; black mycelium in nearly all parts of the culture.

A.M.—absent or loose, white, cottony.

Liquid Cultures

Potato dextrose broth.

Growth—poor, loose mycelial wefts throughout culture, and ring around margin of glass; liquid slightly milky from abundant spore production. No black.

A.M.—none.

Peptone dextrose solution.

Growth—fair to good, liquid covered with mycelial mat which clings to glass around margin. No black.

A.M.—none, or very shallow and powdery.

Strain O₂ = *Verticillium* sp.

Conidia av. $2.35\mu \times 4.61\mu$

Cultures of this strain resemble those of O and P very closely both on solid and liquid media. Black mycelium however, is produced only slightly on potato dextrose agar and not at all on other media.

Strain 15 = *Verticillium* sp.

Conidia $2.6\mu \times 5.3\mu$

Solid Media

On all agars this strain produces copious aerial growth of white to salmon-tinted mycelium. Coremial tufts of mycelium are present. Substratum yellowish on all but prune agar. Conidial production small.

Liquid Media

Potato dextrose broth.

Growth—good; surface of liquid covered by thick, slimy, mycelial mat; mycelium growing up glass at margin for 2 cm. No black.

A.M.—none, except around margin where beautiful moist coremial strands with feathery tips extend into air for 1-1½ cm., salmon tinted.

Peptone dextrose solution.

Similar to that on potato dextrose broth.

Strain 40 = *Verticillium* sp.

Conidia 2.2 μ x 4.6 μ

Solid Media

On all agars this strain produces white, copious, cottony, aerial growth, most abundant on potato dextrose agar and least so on prune agar. Stroma may have brownish discolorations, especially toward top of culture and centre. No black.

Liquid Media

Potato dextrose broth.

Growth—only fair; loose, mycelial wefts throughout culture and around margin. No black.

A.M.—none.

Peptone dextrose solution.

Growth—good; thick mycelial mat covering surface of liquid and growing up glass at the margin for 1 cm. No black.

A.M.—none, or very shallow and powdery.

Strain P₂ = *Verticillium* sp.

Conidia 2.25 μ x 4.64 μ

This strain resembles P in general growth on solid and liquid media, but does not produce any black mycelium.

Strain B = *Verticillium* sp.

Conidia 2.4 μ x 4.31 μ

Solid Media

Stroma—wrinkled and somewhat slimy on nitrate dextrose agar. No black on any medium.

Copious, white, cottony, aerial mycelium produced on all agars. Mycelium slightly creamy on peptone dextrose and on peptone lactose agars. Guttation sometimes present on peptone dextrose agar.

Liquid Media

Potato dextrose broth.

Growth—good; mycelial mat covers liquid and clings to glass at margin.

A.M.—covers mycelial mat, white, cottony, but shallow.

Peptone dextrose solution.

Similar to that on potato dextrose broth, but more aerial mycelium.

Strain 66 = *Verticillium* sp.

Conidia 3 μ x 6 μ

In 1925 and again in 1926, the *Verticillium* strain 66, listed above, was found fruiting in nature on wilted canes of both red and black raspberries. Plate 9, fig. 3, shows conidiophores as growing in nature from canes of black raspberry. The organism was isolated directly from the external fructification on the canes, where normal, verticillate conidiophores and heads of spores were present. The pathogenicity of this strain has not been definitely determined. In culture the colonies produce abundant, mycelial growth, varying in colour from white to pale buff. The mycelium tends to grow in small coremial clusters, and the abundant production of heads of spores gives the cultures a powdery appearance. No black is produced in culture. The conidia average $3\mu \times 6\mu$ in size, which compares with $2.25\mu \times 4.17\mu$ as the average size of conidia of *Verticillium ovatum*.

DISCUSSION OF CULTURAL STUDIES.—In these cultural studies of the *Verticillium* strains, certain general features and tendencies were observed. The production of black in any strain, whether by microsclerotia or by dark mycelium, was invariably more pronounced and more abundant during the first few months after isolation than after the culture had become a year or more old. Cultures also tend to produce a more copious aerial mycelium with age. Strains K and C are best examples of this tendency. Both of these were jet black cultures on nearly all media when first isolated in September, 1925. At this time also the aerial mycelium was either wanting or occurring only in scattered patches. By May, 1926, the cultures showed black on potato dextrose, nitrate dextrose, and prune agars only, and to a much less degree than formerly, while at the same time the aerial mycelium had become abundant over the whole surface of the colony. The following strains are further examples of these tendencies: A, P, T, 58, 59. Numbers 58 and 59 were isolated by Harris and van der Meer respectively, and showed black in culture for only two generations after their receipt at this laboratory.

Strains, such as O and P, which are entirely slimy and moist when first isolated, may, with age, be covered or partially covered by a white mycelial growth. A subculture may be slimy for the first week or ten days of its growth and later develop a covering of aerial mycelium.

Drying out of the substratum favours production of microsclerotia or of black mycelium. This is noticeable at the top of agar slants, where the medium is thinnest and is the first part of the slant to become dry. Especially in the case of strains which are slow to produce black, such colour invariably shows up first at the upper part of the slant.

Various other factors may influence black production. In a petri dish, where scattered colonies grow into contact with one another there is usually heavy black production along the lines of contact. Where colonies in petri dishes grow toward a bacterial colony, or toward an area where the medium is thin, the black production is often more than normal. Where mycelial growth comes in contact with the glass, either in test tubes or in petri dishes, there is usually an extraordinary abundance of microsclerotia or of black mycelium.

The H-ion concentration in a medium has a direct effect upon the amount of black mycelium or of microsclerotia produced. Strain A produces black microsclerotia to some extent on peptone dextrose agar having an acidity of 0, -10, or -20 Fuller's scale, but at +10 and +20 fewer microsclerotia are present and none at +25. On potato dextrose agar, *Verticillium ovatum* does not produce microsclerotia at an acidity of +25, while cultures are jet black at +15 and lower. Strain O produces only a trace of black mycelium at +25 on potato dextrose agar, but considerably more at lower acidities.

KEY TO STRAINS OF *VERTICILLIUM*

Based on cultures fourteen (14) days old.

Black colour produced in cultures.

Black colour formed by microsclerotia.

Microsclerotia producing a black crust on surface of medium. Aerial mycelium more or less scanty, or wanting.

Black crust on all agar media but peptone dextrose: Conidia oval.

Strains A, C, E, R, V, 41, 56, 61, 62, 63, 64

Black crust on all agar media but peptone dextrose and nitrate dextrose: conidia elongate Strain D

Microsclerotia produced on surface of media, covered above by copious aerial mycelium, and visible only from below.

Pale yellow imparted to substratum Strain M

Substratum colourless

Black on prune agar only, and to slight extent Strain 65

Black on all agar but peptone dextrose.

Cultures showing abundant black in 14 days.

Liquid cultures producing moist surface mat Strains K, C₂Liquid cultures producing white aerial mycelium Strains E₂, 57, R₂

Cultures showing very little black in 14 days Strains 58, W, T, 50

Black colour formed by black mycelium.

Aerial mycelium abundant, white. Black production scarce Strain 59

Aerial mycelium scant, cultures usually slimy.

Abundant black in 14 days Strains O, P

Very little black in 14 days Strain O₂

No black colour produced in cultures.

Substratum pale yellow.

Aerial mycelium coremial, and often pale salmon in parts.

Conidial production, small: average size $2.6\mu \times 5.3\mu$ Strain 15Conidial production, abundant: average size $3\mu \times 6\mu$ Strain 66

Substratum colourless, aerial mycelium not coremia-like.

Liquid cultures producing moist surface mat.

Abundant white aerial mycelium on agar Strain 40

Cultures slimy Strain P₂

Liquid cultures producing white aerial mycelium on the surface mat Strain B

ASTER WILT

The average annual loss due to aster wilt in Ontario is ten to twenty per cent. Where soil is aster-sick the entire crop is usually lost. All varieties of asters seem to be susceptible to wilt.

Isolations made at St. Catharines show that many species of *Fusarium* infest wilted plants. Seven different *Fusaria* were isolated and tested for pathogenicity, and, of these, four proved to be strong pathogens. The most common pathogen met with was *Fusarium conglutinans* var. *Callistephi* Beach. The other three *Fusaria* have not been named and further study is necessary before this can be done.

Inoculation experiments at different temperatures showed that infection was slight at temperatures of 17-20° C., and severe at temperatures of 20-25° C. Wilt was equally severe on clay, loam, and sandy soils.

EXPERIMENTS IN CONTROL

Experiment 1.—Seed and Soil Treatment Tests

Four flats were used in this experiment, both seed and soil being inoculated in all cases with the Ontario isolations of *F. conglutinans* var. *Callistephi*. Two hundred seeds were planted in each flat on May 9. Mercuric chloride 1-1000 was used to treat seed or soil of the different flats as shown in the following table.

TABLE 37—EXPERIMENT 1. SEED AND SOIL INOCULATED IN ALL FLATS

No. of flat	Treatment of seed	Treatment of soil	May 23	Healthy plants	
				June 10	Sept. 23
1.....	None.....	None.....	72	66	7 (stunted)
2.....	None.....	HgCl ₂ 1-1000	114	114	18
3.....	HgCl ₂ , 1-1000, $\frac{1}{2}$ hr.....	HgCl ₂ 1-1000	123	123	25
4.....	HgCl ₂ , 1-1000, $\frac{1}{2}$ hr.....	None.....	103	93	14 (stunted)

The flats were too small for the number of plants which came up, and crowding resulted in the loss of many seedlings. The good growth and fine bloom of the remaining plants, however, in flats two and three, show that the wilt was held in check fairly well by soaking the infested soil with a 1-1000 solution of mercuric chloride. Seed disinfection alone, as in flat No. 4, did not materially reduce the losses, since the organism was already present in the soil. This experiment shows that, in such cases, the soil as well as the seed must be treated.

Experiment 2.—Seed Treatment Tests

In this experiment mercuric chloride, Bayer compound, Bayer dust, and Uspulun were tested for efficiency as seed disinfectants. These four materials were each used to treat two different lots of one hundred seeds each of asters. These seeds had been previously inoculated in a spore suspension of *F. conglutinans* var *Callistephi*. The seed disinfection treatments were for one-half hour at the following strengths:—

Mercuric chloride.....	1:1000
Bayer compound.....	.25% solution.
Bayer dust.....	A quantity equal to the volume of the seed.
Uspulun.....	.25% solution.

After treatment, one lot of each seed was sown in a pot of sterilized soil, while the other lot was planted in a pot of soil which had been first sterilized and then inoculated with the aster wilt *Fusarium*. Three checks were arranged as follows: (1) no inoculation, (2) seed only inoculated, and (3) seed and soil inoculated. The results are shown in the following table:—

TABLE 38—SEED TREATMENT TESTS

No. of pot	F. 1 Inoculum	Seed Treatment	Healthy plants			
			Dec. 30	Jan. 27	Feb. 12	Feb. 27
1.....	None.....	None.....	39	39	38	38
2.....	Seed only.....	None.....	50	31	22	14
3.....	Seed and soil.....	None.....	54	20	6	5
4.....	Seed only.....	HgCl ₂ 1:1000.....	38	43	39	36
5.....	Seed and soil.....	HgCl ₂ 1:1000.....	46	30	9	5
6.....	Seed only.....	Bayer compound 25%.....	43	29	16	13
7.....	Seed and soil.....	“ “.....	62	34	10	8
8.....	Seed only.....	Bayer dust.....	54	39	27	14
9.....	Seed and soil.....	“ “.....	49	24	9	4
10.....	Seed only.....	Uspulun 25%.....	56	56	54	52
11.....	Seed and soil.....	“ “.....	46	25	2	2

Pots 1, 2, and 3, of this experiment show that inoculated seed on clean soil does not produce such severe losses as are experienced when the soil as well is infested with the organism. Pots 4 to 11 show that on clean soil where seed alone is inoculated, mercuric chloride 1:1,000 or Uspulun 0.25 per cent solution

satisfactorily check the disease. However, where the soil is badly infested, not much is gained from seed disinfection as is shown by results in both Experiments 1 and 2.

In inoculation experiments it was noted that individual plants would remain healthy while the remaining ones wilted. Such plants were allowed to grow and to produce seed, wherever possible, in the hope that a resistant strain of asters might be secured. This seed has been tested in comparison with commercial seed and has shown some resistance.

Control recommendations are as follows:—

- (1) Disinfect the seed for $\frac{1}{2}$ hour in 1:1000 Mercuric Chloride solution.
- (2) If asters are started indoors it is profitable to steam sterilize the soil used for this purpose or, failing this, to use soil on which asters have not grown.
- (3) Plant asters outdoors on land which has not grown asters for some years, avoiding as far as possible land on which aster wilt is known to occur year after year.
- (4) Selection of home-grown seed is to be encouraged.

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REPORT OF THE DOMINION RUST RESEARCH LABORATORY, WINNIPEG, MAN.

(D. L. Bailey, Officer in Charge)

PHYSIOLOGIC FORMS OF WHEAT STEM RUST (Margaret Newton and T. Johnson)

As stated in the 1925 report of the Dominion Laboratory of Plant Pathology at Saskatoon, the work on the physiologic forms of wheat stem rust was transferred to the Winnipeg laboratory during the summer of 1925. A comprehensive rust survey of the three Prairie Provinces was made and the results are presented in Table 39. Six physiologic forms were isolated.

TABLE 39—DISTRIBUTION IN WESTERN CANADA OF THE PHYSIOLOGIC FORMS OF
P. graminis Tritici, 1925

Physiologic form	Number of times form was collected in				Total number of times each form was collected
	Extreme Western Ontario	Manitoba	Saskatchewan	Alberta	
21.....	2	35	5	2	44
29.....		11	2		13
30.....		1			1
32.....		2	1		3
34.....		1			1
36.....	4	76	26	7	113
Total number of collections made.....	6	126	34	9	175

In 1926 the scope of the rust survey was extended to include the whole of Canada and collections were made in all the provinces, except British Columbia. The results for 1926, presented in Table 40 are incomplete and represent only forms identified up to November 15. A large proportion of the rust collections made in Western Canada is included in this table, while most of the rust from Eastern Canada, which was collected later in the season, still remains to be determined. Seven physiologic forms have been isolated up to date.

TABLE 40—DISTRIBUTION IN CANADA, OF THE PHYSIOLOGIC FORMS OF *P. graminis Tritici*, 1926*

Physiologic form	Number of times form was collected						Total number of times each form was collected
	Alta.	Sask.	Man.	Ont.	Que.	P.E.I.	
10.....				1			1
17.....			3	1			4
21.....		10	26	2	1	3	42
29.....		5	7				12
30.....			3				3
34.....		1					1
36.....	5	61	69	5	1	2	143
Total number, collections made.....	5	77	108	9	2	5	206

* This table is incomplete, representing only rust collections identified up to November 15, 1926.

It will be noted that there is a close correlation between the results for these two years. The two physiologic forms, 36 and 21, predominated in approximately the same proportion both years. Form 36 occurred in 65 per cent of the collections in 1925, and in 69 per cent of those made in 1926. Form 21 occurred

in 25 per cent of the collections made in 1925 and 20 per cent of those made in 1926. These two forms comprise 89.7 per cent of all collections made in 1925, and 89.8 per cent of all collections identified up to November 15, 1926. In both years form 29 was the third most frequently occurring physiologic form, while the remaining forms in the tables occurred but rarely. These comparisons, of course, apply only to Western Canada, because no rust was collected in Eastern Canada in 1925, and the majority of that collected in 1926 has not yet been identified.

The two predominating forms differ widely in their reactions on certain wheat varieties. While Marquis is susceptible to both forms, the durum wheats are generally resistant to form 36, and susceptible to form 21. Since form 21 appears to be more virulent than form 36, one might expect that it would be more prevalent in the field. As has been pointed out above, however, such is not the case. For some unknown reason there seems to be no correlation between the apparent virulence of a physiologic form and its prevalence in the field.

PHYSIOLOGIC FORMS OF OAT STEM RUST

(W. L. Gordon and D. L. Bailey)

This project has been continued from last year. Sixty collections of oat rust were obtained from various localities in Canada, and cultured in the greenhouse. From these were isolated thirty-three cultures of form 2, thirty-one of form 5, two of form 1, and one of form 3.

Physiologic forms of oat stem rust, more virulent than any of these mentioned above, were collected from three widely separated points in Saskatchewan. The occurrence of these forms in Canada renders the oat stem rust problem much more difficult. All the varieties which have been resistant to the present time appear to be susceptible to them. It is essential that a more extensive survey be made to determine whether these forms are widely distributed, and a search be made for varieties resistant to them.

The origin of the various collections and the forms isolated from them are summarized in table 41.

TABLE 41—PHYSIOLOGIC FORMS OF *Puccinia graminis Avenae* IDENTIFIED IN 1925-26

Origin of collection	Physiologic forms present	Origin of Collection	Physiologic forms present
Manitoba:		Saskatchewan:	
Boissevain.....	2 and 5	Assiniboia.....	2
Brandon.....	2	Carlyle.....	2
Brunkild.....	2	Fairlight.....	3 and ?
Crystal City.....	5	Indian Head.....	2 and ?
Dauphin (2).....	2 and 5	Limerick.....	5
Deloraine.....	5	Pangman.....	5
Grandview.....	5	Paswegin.....	?
Gilbert Plains (3).....	5	Rosthern.....	2
Hartney.....	5	Saskatoon.....	2
H. B. R. Mile 43.....	2	Stenen.....	5
Kelwood.....	5	Talmage.....	2
Killarney.....	5	Ontario:	
La Rivière.....	5	Dorion.....	2
Laurier.....	5	Kapuskasing.....	2
Macdonald (2).....	1, 2, 5	Thunder Bay.....	2
McCreary (2).....	1, 2, 5	Quebec:	
Morden (3).....	2	Hemmingford.....	2
Morton.....	5	Lachute.....	2
Neepawa.....	5	Macdonald College.....	5
Norway House.....	2	New Brunswick:	
Oak Lake.....	5	Fredericton.....	2
Ochre River (2).....	2	Nova Scotia:	
Plum Coulee.....	2 and 5	Gaspereaux.....	2
St. Eustache.....	2 and 5	P. E. Island:	
St. Norbert.....	2 and 5	Charlottetown.....	5
St. Rose.....	2		
Stonewall.....	5		
Virten.....	2 and 5		
Westbourne.....	2		

FIELD TESTS OF EARLY MATURING AND RUST RESISTANT VARIETIES OF WHEAT

(Margaret Newton, T. Johnson, and D. L. Bailey)

In 1920, field experiments were begun by Prof. W. P. Fraser, in co-operation with the various Dominion Experimental Farms and western universities, to determine the relative susceptibility of some early maturing varieties, and varieties of wheat known to possess a certain amount of resistance to stem rust. In these plots were also included a number of wheats which Stakman and Levine had used as differential hosts in their work on physiologic specialization. It was thought that these latter wheats might act as traps for physiologic forms of rust, and that by this means a more accurate record could be obtained of the number of physiologic forms present at each station (see Report of Division of Botany, 1922-1925).

The past year's work, therefore, is but a continuation of the work which has been carried on since 1920. During these years a number of new varieties have been added to the original list sown at each station, and a number of the old varieties have been dropped from the list, either because, after a four or five years' test, they have given a similar rust reaction to a number of varieties already included in the test plot, or because these varieties have shown that they possess no real rust resistance. Their apparent rust resistance in certain localities was due to the presence or absence of distinct forms in those localities.

In table 42 is recorded the percentage of stem rust on 23 varieties and species of wheat grown at 17 different stations in Canada in 1926. The rows were examined and the percentage of rust estimated about the time of the ripening of the grain.

TABLE 42.—PERCENTAGE OF STEM RUST ON 23 VARIETIES AND SPECIES OF WHEAT GROWN IN UNIFORM RUST NURSERIES AT 17 STATIONS IN CANADA IN 1926

Wheat		Summerland, B.C.	Lethbridge, Alta.	Lacombe, Alta.	Edmonton, Alta.	Scott, Sask.	Rosethorn, Sask.	Saskatoon, Sask.	Swift Current, Sask.	Indian Head, Sask.	Brandon, Man.	Winnipeg, Man.	Morden, Man.	Kapuskasing, Ont.	Ottawa, Ont.	Ste. Anne de la Po- catière, Que.	Keniville, N.S.	Charlottetown, P.E.I.
		Percentage of infection																
Durum—	Acme C.I. 5284.....	0	0	0	0	0	0	0	0	0	0	30	tr.	tr.	tr.	tr.	tr.	0
	Arnautka, C.I. 4064.....	0	0	0	0	0	0	0	0	0	tr.	35	tr.	tr.	tr.	tr.	tr.	5
	Iumillo, R.L. 7.....	0	0	0	0	0	0	0	0	0	0	tr.	tr.	tr.	0	tr.	tr.	0
	Kubanka, C.I. 1440.....	0	0	0	0	0	0	0	0	0	tr.	40	50	5	10	tr.	tr.	20
	Mindum C.I. 5296.....	0	0	0	0	0	0	0	0	0	tr.	40	20	tr.	tr.	tr.	tr.	tr.
Common Hard Red—	Axminster R.L. 75.....	0	0	0	0	0	0	0	0	tr.	tr.	60	65	38	5	25	30	25
	Ceres N.D. 1658.....	0	0	0	0	0	0	0	0	0	0	35	50	25	tr.	40	32	20
	Garnet Ott. 652.....	0	0	0	0	0	0	tr.	0	0	tr.	58	65	77	15	25	85	85
	Kota C.I. 5878.....	0	0	0	0	0	0	0	0	0	tr.	35	49	30	tr.	30	50	10
	Marquillo R.L. 59.....	0	0	0	0	0	0	0	0	0	tr.	30	35	5	5	15	60	5
	Marquis Ott. 15.....	0	0	0	0	0	0	tr.	0	0	5	60	70	40	20	50	60	30
	Mar. x Kan. C.I. 7370.....	0	0	0	0	0	0	0	0	0	tr.	60	66	42	5	40	45	40
	Mar. x Kota N.D. 81.....	0	0	0	0	0	0	0	0	0	tr.	65	43			15		
	Mar. x Kota N.D. 1656.....	0	0	0	0	0	0	0	0	0	tr.	35	45	23	tr.	25	10	5
	McKenzie R.L. 232.....	0	0	0	0	0	tr.	0	0	0	tr.	58	65	28	5	35	50	15
	Parker's R.L. 71.....	0	0	0	0	0	0	0	0	0	tr.	62	65	30	5	40	50	15
	Red Quality A.R.L. 69.....	0	0	0	0	0	0	0	0	tr.	tr.	63	72	40	20	30	60	15
	Reward Ott. 928.....	0	0	0	0	0	0	0	0	tr.	tr.	58	72	60	15	30	10	30
Common White	Little Club C.I. 4066.....	0	0	0	0	0	0	tr.	0	0	5	65	68	60	20	65	75	85
	Quality R.L. 133.....	0	0	0	0	0	0	0	0	0	tr.	60	80	38	20	35	20	40
Emmer—	Khapli C.I. 4013.....	0	0	0	0	0	0	0	0	0	0	3	5	tr.	0	tr.	15	0
	Vernal C.I. 3866.....	0	0	0	0	0	0	0	0	0	0	15	0	0	tr.	0	0	0
Einkorn—	Einkorn C.I. 2433.....	0	0	0	0	0	0	0	0	0	tr.	5	tr.	tr.	0	0	0	0
Examiner—	M. Newton.....	MN	MN	MN	MN	MN	MN	MN	MN	MN	MN	MN	MN	MN	D. L. Bai- ley	H. N. Ra- ci- cot	R. R. Hur- st	R. R. H.

tr.—trace (less than (1%).

As the table indicates, most of the common wheat varieties tested proved to be rather susceptible. Marquillo was the one exception, and in practically every locality, it was the most resistant of the hard red wheats. As in former years, the durumms showed considerable resistance. This year Iumillo and Acme were again among the most resistant. True, it was not an ideal year in which to test the relative rust resistance of wheat varieties in Western Canada, as rust did no significant injury to the wheat crop at any station west or north of Winnipeg. From Winnipeg eastward, the case was quite reversed. So heavy was the outbreak of stem rust that in many cases there was a decided lowering in the grade of the wheat, and hence, all the eastern variety plots received ample rust to test all the varieties therein. Leaf rust was common in both the eastern and western plots.

GREENHOUSE EXPERIMENTS ON THE RELATIVE SUSCEPTIBILITY OF SPRING WHEAT VARIETIES TO SEVEN PHYSIOLOGIC FORMS OF WHEAT STEM RUST

(Margaret Newton and T. Johnson)

The Dominion Department of Agriculture, through the establishment of a Rust Research Laboratory at Winnipeg, is making a serious effort to develop common wheat varieties of satisfactory quality which will be resistant to stem rust. This is being attempted by combining the resistance of partially resistant common wheat varieties.

The relative resistance to rust of these varieties is discovered by means of a series of inoculation experiments whereby these varieties are inoculated with pure lines of physiologic forms. A record is then made of the behaviour of each variety to each form, and the variety is retained or rejected for breeding work according as it is resistant or susceptible.

During the year, twenty-nine promising varieties of wheat have been tested to the seven physiological forms of stem rust which occurred most commonly in the great plains region of Canada. The majority of these wheat varieties have been developed only recently. Considerable resistance to most of the physiologic forms was shown by the following common wheats: Marquillo, McFadden's Emmer, Marquis x Kanred (Minn-B-2-5), Sevier x Dicklow R.R. 368 (g. 149), and Webster. The Marquis x Kanred cross was immune to four of the seven physiologic forms, but susceptible to the remaining three.

An article including all the details of this experiment and the results obtained will be found in the January 1927 issue of "Scientific Agriculture."

FIELD EXPERIMENTS ON THE CONTROL OF STEM RUST BY SULPHUR DUST

(D. L. Bailey and F. J. Greaney)

Preliminary experiments at this laboratory in 1925 (See Report of the Dominion Botanist, H. T. Güssow, for 1925) on the control of stem rust of wheat by dusting with sulphur gave such promising results that further experiments were undertaken this year. These consisted of fortieth-acre plot experiments similar to those of last year and some preliminary field trials in which a horse-drawn traction duster was used. The larger field experiments were conducted in two localities in Manitoba, one at Portage la Prairie, and the other in the Red River valley at St. Norbert.

So very little rust developed at Winnipeg that no conclusions could be drawn as to the relative efficiency in controlling rust of the various rates and frequencies of application of sulphur dust. The experiment did indicate, however, that in the absence of significant amounts of stem rust sulphur had no appreciable effect on yields, even when applied three times per week at the rate of 15 pounds to the acre.

The larger field experiments were likewise not conclusive, due to the light infection of rust which occurred. At Portage a plot, which was dusted five times altogether at weekly intervals at the approximate rate of 30 pounds of sulphur per acre, yielded $4\frac{1}{2}$ bushels per acre more than the check. The plot, which was dusted twice a week, or nine times altogether, at the rate of 15 pounds per acre, did not yield any higher than the check, although rust did not seem much heavier on this plot than on the one which gave the higher yield. Where infection is so light and variable, however, it is very difficult to determine accurately slight differences in the severity of the attack over large areas. While there is some doubt as to whether the increased yield in the one case was due entirely to reduced rust infection, there was no question that rust was significantly held in check in both the treated plots as compared with the untreated ones. This difference was distinct when the crop was still three weeks from maturity, and it seemed certain that the difference would be greatly accentuated during that interval. But hot dry weather with strong winds followed, and this not only hastened the maturity of the wheat, but inhibited further rust development. Considering all these circumstances, the results obtained seem to support those of last year in indicating that this treatment is effective in controlling rust under field conditions.

The results of the St. Norbert experiment were very comparable with those obtained at Portage. There was distinctly less rust on the plots which had been dusted with sulphur than on the untreated plots. But once again there was not enough rust on the check plots to reduce seriously the yields, and, therefore, the results were not conclusive.

The results of this year warrant further field trials to study both the efficiency and the practicability of this method of rust control.

EPIDEMIOLOGY STUDIES

(J. H. Craigie and F. J. Greaney)

(A) FIELD SURVEY

The pycnial stage of stem rust was found on May 22, and the aecial stage on June 3. These dates in both cases are just twelve days earlier than those for last year.

The uredinial stage, however, was not found quite so early as it was last year. On June 30, Mr. Brown of the Morden Experimental Station forwarded to this laboratory several culms of wheat bearing stem rust pustules. Two or three days later Mr. Johnson found infections along the route from Morden northward to Carman. South of Morden, where the soil was heavier and the crops not so far advanced, he found no trace of rust. Beyond Carman northward, traces of rust became very rare, being found only after a long search, or not at all. By July 15, rust could be found without much difficulty at Portage la Prairie, but a general field infection had not developed. Further west, however, toward Brandon and Neepawa, there was practically no trace of rust. In the extreme western part of the province (Virden to Russell), early infections became more prevalent. At this time also primary infections were beginning to appear around Dauphin.

Although rust had appeared in southern Manitoba at the last of June, no field infection occurred in Saskatchewan until July 14. From that date onward to the end of the month, the area of primary infections spread as far westward as Saskatoon. At the middle of August scattered traces of primary infection in eastern Alberta could be found. In neither of these two provinces did rust develop sufficiently to cause any appreciable loss.

An attempt to assign definite reasons why rust developed so lightly in our wheat-growing area would be unwarranted, but two or three causes at least seem to have been operative. Others also may have played a part. The first is that the amount of inoculum was comparatively small. The absence of a heavy infestation of rust in the spring-wheat area of the United States may account satisfactorily for this scarcity. In the second place, during June and the first week of July, a prevailing north wind blew. The general result of such a wind would be to prevent the northward spread of spores. And thirdly, during July and the early part of August partial drought conditions prevailed in many parts of our wheat-growing area, so that, even though spores were present, they did not have an opportunity to germinate, owing to lack of moisture. This, at any rate, seemed to be the conclusion to which field observations led one. Just how much part each of these played is difficult to determine; the resultant effect, however, was that Western Canada had an almost rust-free year.

(B) REPORT ON STATIONARY SLIDE EXPOSURES

(Co-operative experiment between the Dominion Plant Pathological Laboratories at Winnipeg, Man., and Saskatoon, Sask.)

The results of the stationary slide exposures of last year were of such interest that a continuation and expansion of this work for 1926 was decided upon. It seemed especially desirable that data be collected on the earliest appearances of urediniospores and aeciospores of black stem rust at various stations throughout the three prairie provinces, in order to ascertain the progress of the inoculum (spores) as it advanced west and north, and to gain some quantitative index of the inoculum for any given time and station. In addition, it was hoped that something definite regarding the source of our initial infections of rust might be found.

The work was done co-operatively by the Winnipeg and Saskatoon laboratories. The former took care of the exposures for Manitoba, the latter of those for Saskatchewan and Alberta. Mr. G. A. Scott, of the Saskatoon laboratory, was in charge of the work there, and his generous and willing co-operation is gratefully acknowledged.

Glass slides were coated on one side with a thin smear of vaseline, and then placed individually in small mailing cases. Each slide and its mailing case were wrapped in a half-sheet of paper. The paper had newly arrived and might be considered free from rust spores. The wrapping was done as a precautionary measure in order that there should be no possibility later of the other slides becoming contaminated, while one of them was being taken out for exposure at one of the stations. To insure that the slides would have the best possible exposures and at the same time be protected from rains, a weather-vane type of spore "trap" (plate 13, fig. 1) was used which protected a slide from the rain, but gave free access of air currents to it. These were modelled after one designed several years ago by Mr. P. M. Simmonds of the Saskatoon laboratory. The traps were sent out to various stations to men who had previously expressed their willingness to assist in the work. Along with the traps were sent a package of the prepared slides and record sheets on which weather conditions during the period of each exposure were to be recorded. The kind and generous assistance of these men made the carrying on of the work practicable, and appreciative acknowledgment is made of their services.

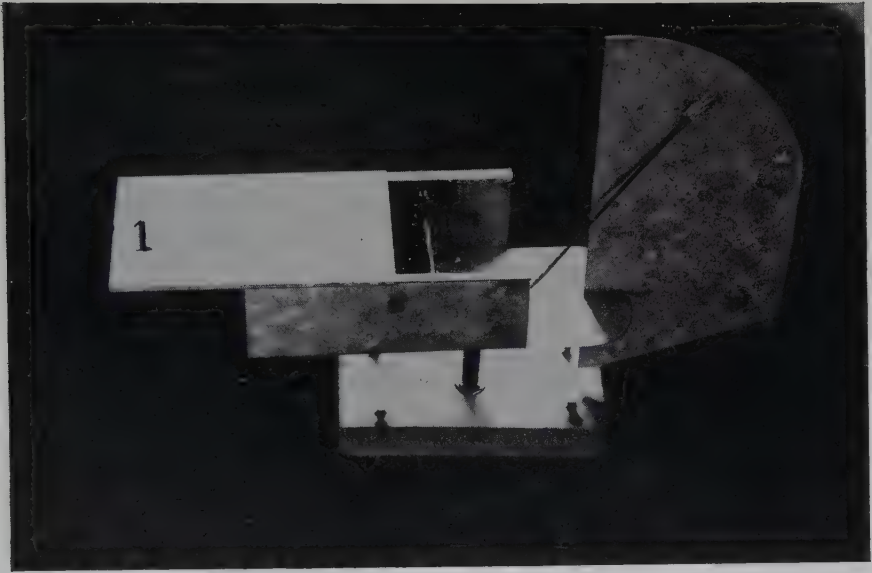


PLATE 13

Fig. 1.—Spore trap with cover partly removed to show glass slide in position.
 Fig. 2.—Map showing stations at which stationary slides were exposed.

A list of the places at which spore traps were placed is given in table 43. It was hoped that, by such a distribution of the traps (see map, plate 13, fig. 2), a fair index of the general spread of the rust would be furnished as well as an indication of the severity of the attack. The two most southerly stations, Morden and North Portal, were chosen because they were near the international boundary, and the earliest arrival of spores would most probably be detected there. Beaverlodge, the most northerly one, on the other hand, was selected because it was outside the area in which stem rust developed on cereals and grasses. Hence the slides exposed there would give some clue to the west and northward spread of the spores. The other points would furnish intermediate data on the spread and abundance of rust spores.

TABLE 43.—PLACES AT WHICH SLIDES WERE EXPOSED, WITH THE PERIODS OVER WHICH THE EXPOSURES TOOK PLACE, THE DURATION OF EACH EXPOSURE, AND THE TOTAL NUMBER OF SPORES CAUGHT AT EACH STATION

Place	Period of exposures	Duration of exposures	Total number of spores
		days	
Morden, Man.....	June 2-Sept. 2	1	255,142
Winnipeg, Man.....	" 2- " 4	1	28,712
Brandon, Man.....	" 12-July 31	2	67
Norway House, Man.....	Aug. 21-Sept. 23	3	64
North Portal, Sask.....	June 15-Aug. 31	3	97,603
Indian Head, Sask.....	" 1- " 31	1	2,441
Saskatoon, Sask.....	" 1- " 31	1	873
Speddington, Sask.....	" 15- " 31	3	145
Swift Current, Sask.....	July 1-Sept. 1	3	14
Vermilion, Alta.....	" 1- " 1	3	14
Lethbridge, Alta.....	" 1- " 1	3	39
Olds, Alta.....	" 15-Aug. 31	3	36
Edmonton, Alta.....	" 15- " 31	3	21
Beaverlodge, Alta.....	" 15-Sept. 1	3	0

Spore counts of the slides were made. The area agreed upon by both laboratories for examination was that covered by a 22 by 40 mm. cover-glass. Although the method of exposing the slides this year was not the same as last year and a comparison of the number of spores on the slides for a given period cannot fairly be made, nevertheless it might be pointed out that, for the period July 14 to July 18, the number of spores found at Winnipeg this year on the slides was less than half of the number found last year for the same period. For the month of August also, the number of spores was much less.

The total number of spores recorded for Brandon is small, owing most likely to the fact that the slides were exposed during a period at which few spores could be detected in the air as far north as Winnipeg or Brandon. It is quite probable that during the month of August, if slides had been exposed they would have showed a very considerable increase in the number of spores.

In many respects the summer was an unsatisfactory one for epidemiology studies. With the exception of a few localities in Manitoba, damage from rust throughout the Prairie Provinces was negligible. Owing to drought and other unfavourable conditions in many sections of the Mississippi valley, a general epidemic of rust did not occur there. As an apparent consequence, rust in Canada was small in amount and only developed severely where local environmental conditions were specially favourable. Table 44 contains a brief summary of the results.

TABLE 44.—DATE OF FIRST SPORES ON SLIDES AT THE VARIOUS STATIONS, DATE OF EARLIEST FIELD INFECTION IN VICINITY OF STATIONS, AND TOTAL NUMBER OF SPORES FOUND ON THE SLIDES EACH MONTH

Station	Date of first spores on slides	Date of first field infection	Total spores for June	Total spores for July	Total spores for August
Morden, Man.....	June 4	June 30	8	130,793	122,149
Winnipeg, Man.....	" 5	July 4	10	4,319	24,224
Brandon, Man.....	July 18	" 20	0	67	No exposures
North Portal, Sask.....	June 25	.....	2	175	97,426
Indian Head, Sask.....	" 24	Aug. 1	9	151	2,281
Speddington, Sask.....	July 28	" 3	0	6	139
Swift Current, Sask.....	Aug. 1	" 12	0	0	14
Lethbridge, Alta.....	" 7	nil (Aug. 12)	0	0	39
Olds, Alta.....	" 12	Aug. 17	0	0	36
Vermilion, Alta.....	" 28	nil (Aug. 24)	0	0	14
Edmonton, Alta.....	" 24	nil (Aug. 23)	0	0	21
Beaverlodge, Alta.....	.....	.....	0	0	0

The results for Morden and Winnipeg in table 44 are interesting. At Morden one urediniospore was caught by the slide exposed on June 4. At Winnipeg five spores were caught on June 5 and two on June 6. For a space of three weeks afterwards no more spores were found on the slides at either stations. During the last week of June, however, spores again appeared, not only at these two stations, but at North Portal, Indian Head, and Saskatoon, in Saskatchewan. Throughout that week it seemed that spores in comparatively small numbers pervaded the atmosphere. Subsequently spores were picked up more or less regularly at these stations until the end of August, when the exposures were for the most part discontinued. The presence of spores at both Morden and Winnipeg at approximately the same time seems to indicate that a light shower of spores fell in southern Manitoba during the first week of June, but did not extend into Saskatchewan, at least to any extent, otherwise its presence would likely have been detected at Indian Head, where slides were being exposed at that time. The fact, that field infections occurred in Manitoba from two to three weeks earlier than in Saskatchewan is confirmatory of such an assumption.

In Alberta, no spores were found on the slides throughout July, but, excepting Beaverlodge where no spores were found at all, the slides exposed during August succeeded in picking up some spores, although not many. As there was practically no rust in Alberta, sparse infections (chiefly in the eastern part) only being discoverable as late as the middle of August, it is probable that the spores caught by the slides originated further east, and were caught up during reaping and threshing operations by winds and carried westward.

The last three columns of table 44 are inserted to indicate the distribution of spores by months at the various stations, and to show that, almost in proportion as the station is situated further west and north, the amount of inoculum is gradually diminished and the date of its arrival retarded.

(c) RESULTS OF SPORE-TRAPPING EXPERIMENTS—AEROPLANE EXPOSURES

(Co-operative Experiment between the Royal Canadian Air Force and the Dominion Plant Pathological Laboratory at the Manitoba Agricultural College, Winnipeg).

The purpose and scope of this work have been outlined in the Dominion Botanist's Report for 1925. The aeroplane exposures attempt to collect, as far as possible, for altitudes between one and five thousand feet, data of the same nature as the stationary slides collect at the earth's surface such as, the date

of the earliest appearance of rust spores, the region over which they first appear, the rate at which the spore content of the air increases over various regions, the viability of spores caught at these higher altitudes, and the relation of certain environmental and climatic factors to the rate of development and spread of rust.

Adopting the method followed last year, microscope slides lightly smeared on one side with vaseline and secured to wooden paddles were placed in tightly stoppered bottles (plate 14), to prevent contamination before and after exposure, and were forwarded to the Officers Commanding the Air Force Substations at Lac du Bonnet, Norway House, Cormorant Lake in Manitoba, and High River in Alberta. The slides were exposed on routine flights during July, August, and September at altitudes between 1,000 and 5,000 feet. For practically all exposures the time was 15 minutes.

In table 45 are summarized the results of these exposures. As Norway House and Cormorant Lake are relatively close geographically, they are treated in the table as being a single station. In explanation of the figures given in the table it is necessary to state that each paddle held two slides. Rarely did it happen that the area examined on both slides possessed the same number of spores. In the table, therefore, the numbers given are for the slide of each exposure which had the greater spore count per area examined, the area in each case being 880 (22 x 40) square millimetres.

TABLE 45.—STATIONS AT WHICH EXPOSURES WERE MADE WITH THE DATE, ALTITUDE, AND NUMBER OF SPORES FOR EACH

Date	Lac du Bonnet		Norway House and Cormorant Lake		High River	
	Altitude	No. of spores	Altitude	No. of spores	Altitude	No. of spores
1926						
July 9.	2,400	0				
12.	5,000	0	5,000	0		
15.	1,500	0				
16.	3,300	0				
16.	3,300	0				
17.			5,000	0	4,500	0
20.					5,000	0
21.	4,900	3				
23.	5,000	2				
24.			3,500	0		
25.			3,000	1 ¹	5,000	0
26.	5,000	29	4,000	0		
27.	5,000	3				
28.	5,000	17				
29.					5,000	3
Aug. 3.	5,000	2	5,000	1		
7.	5,000	3,265				
9.					4,800	0
10.			3,000	0		
12.	5,000	0				
13.					1,000	0
14.	5,000	0	4,000	4		
17.			4,000	2		
24.	5,000	13				
25.			3,400	0 ¹		
28.			3,000	4 ¹	2,500-5,000	0 ¹
29.					5,000	0
30.	5,000	83			1,000-5,000	1
31.			3,000	16	5,000	0
Sept. 9.	5,000	13	5,000	0		
11.	4,500	2				
13.	5,000	2				
14.			3,000	0		
15.	5,000	184 ¹				
19.	5,000	6				

¹ Two or more exposures made on same date over different areas.

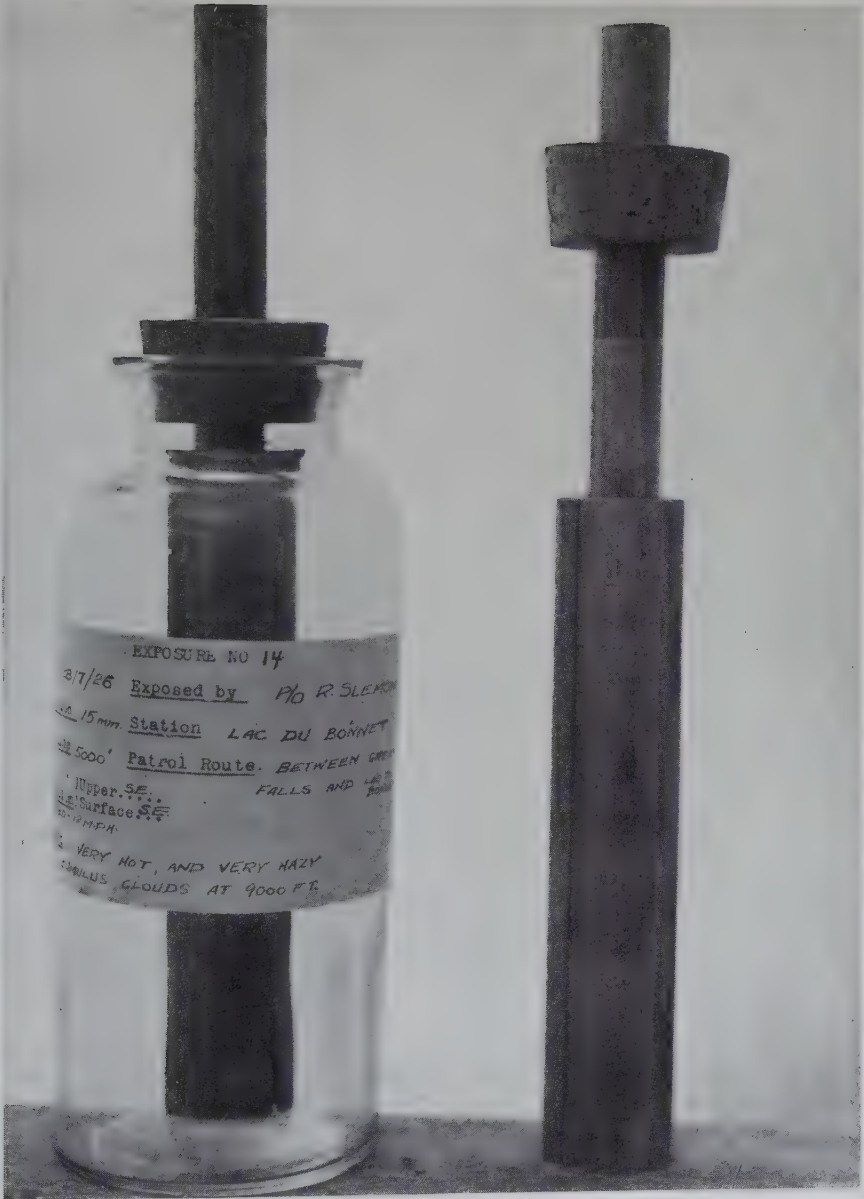


PLATE 14.—(Left) Bottle containing paddle and two slides, with data of exposure.
(Right) A paddle, with one slide partly removed, to show detail.

It will readily be seen from a glance at this table that stem rust spores were not much in evidence in the upper air during the summer of 1926. This paucity of spores may be attributed directly to the limited amount of rust this year in the wheat fields of the United States and Canada. With such limited data available, it is perhaps unwise to draw any conclusions, but attention should be drawn to the fact that on July 31 three spores were picked up at High River, Alberta, by the aeroplane exposure, whereas it was not until August 24 that any were detected by the stationary slides exposed at that station. Field infections were not found in Alberta until the middle of August and then only rarely, and, at the time when these spores were caught, primary infections were just beginning to appear in southeastern Saskatchewan. From these circumstances one must conclude that the source of the spores caught on the slide of July 31 must have been southern Manitoba or some place south of the international boundary.

Another point of interest is that, although the number of spores caught by the slides was generally low, the number for a slide exposed at Lac du Bonnet on August 7 was surprisingly high. The altitude for the exposure was 5,000 feet and the duration 15 minutes. A southwest wind of from 15 to 20 miles per hour was blowing at both the earth's surface and at the higher altitude. It seems as though the plane had the good fortune to traverse a pocket or eddy of air where the concentration of rust spores was very dense. The number of leaf rust spores on this slide was also much higher than for other exposures. Just where these spores originated is purely speculative, but during the first week of August harvesting had been going on in the vicinity of Morden, where there was a heavy local outbreak of rust, and from an examination of the stationary slide exposed at Morden it is quite evident that a great number of spores were liberated into the air at that time. On the stationary slide exposed on August 4, 48,394 rust spores were found on an area of 880 sq. mm. On August 1, 49,032 were found on the same area. Wherever the cloud of spores indicated by the slide of August 7 originated, it is quite improbable that it could have had its source further north than Morden, for, on that date, except for a small artificially-produced epidemic in the experimental plots at the Agricultural College, Winnipeg, rust could only be found with difficulty in the vicinity of Winnipeg, or at places farther north.

A somewhat similar case occurred in 1925. The slide exposed by aeroplane on August 5 had an equally heavy load of spores, more than four times the number for the second highest exposure for that year.

Heavily rusted areas were of limited size this year in both Canada and the United States. When the patchy nature of these outbreaks is considered, one is led to suspect that there may be some relation between these clouds or eddies of spores and localized heavy field infections. The idea is sufficiently fanciful, but one can imagine a rain washing these spores down on a more or less limited area, where they would germinate and produce a heavy infection.

(D) OVERWINTERING OF UREDINIOSPORES OF STEM RUST

The possibility of initial infections arising from overwintered urediniospores or mycelium of stem rust has never been demonstrated positively; all experimental evidence has indicated that overwintering does not take place, at least in the Prairie Provinces. On the other hand, an infection occasionally is found which, with our present knowledge, is very difficult to explain, except on the assumption that overwintering does take place. For instance, on July 18, 1926, Dr. Sanford discovered an infection northwest of Saskatchewan, in a field of Dr. Seager Wheeler, of Rosthern, Sask. The corner where the infection occurred was very well sheltered by trees. Secondary infection had already taken place, so that the initial infection must have occurred two or three weeks previously.

On July 15, three days earlier, the first pustule of rust was found in southeastern Saskatchewan, where the earliest infections in that province regularly occur. It is difficult to see how an infection would originate, so far north, a fortnight or more before infections appeared in the southern part of the province, if the source of the infection was wind-blown spores. Another case occurred at Saskatoon in the Field Husbandry plots of winter wheat. Quite a severe infection broke out before any trace of rust could be found in the rust nursery or on any of the spring wheats. Circumstantially there seems to be in both cases some evidence of overwintering.

Throughout the winter of 1925-26 germination tests were made of uredinio-spores obtained from beneath the sheaths of heavily rusted *Hordeum jubatum*. These tests were made every two weeks, fresh material being brought into the laboratory for each test. A low percentage of germination, 0.5 per cent or 2 per cent occurred up to April 24, but after that date no further germination took place.

A series of weekly inoculations was begun on the first of March and continued on to the last of April. Little Club wheat was used as the host. The inoculum was gathered from underneath the culms of *Hordeum jubatum* brought in from outside at each time of inoculation. In no instance did infection occur. This result is not surprising when the low percentage of germination already stated is considered.

In the fall several rows of winter wheat were heavily infected with rust by means of artificial inoculation in order that some study could be made of the possibility of mycelium surviving the winter and becoming a potential source of infection in the spring. The rows were covered with a thick layer of straw to afford some extra protection, but, unfortunately, all the plants were winter-killed and thus rendered useless.

SMUT INVESTIGATIONS

(I. L. Conners)

CONTROL OF SMUT BY SEED TREATMENT

The principal experiments in the control of smut by seed treatment were conducted in co-operation with the Dominion Experimental Farms. In these experiments the effectiveness of various substances in controlling wheat bunt and covered smut in hulless and common oats was tested. For the purposes of this report a summary of the experiments and a short discussion of the results obtained are here given.

In the experiments with wheat bunt, naturally-infected seed was used. Three seed treatments, formalin, "Corona" and "Mococo" copper carbonates, were run at each of the four co-operating stations, Brandon, Man., Indian Head and Scott, Sask., and Lacombe, Alta. A number of additional treatments, including other brands of copper carbonate and the organic mercuric compounds, were tried at one or more places. The untreated check plots developed considerable bunt, while very little developed in any of the treated plots. The six brands of copper carbonate that were tested belonged to two classes, the one containing 50 per cent copper and the other approximately 20 per cent. Both classes were about equally effective. "Corona" colloidal copper was not superior to copper carbonate. DuPont dust No. 12, an organic mercury compound in dust form, gave promising results in the single test made. The organic mercury compounds, Semesan, Uspulun, Germisan, and Tillantin, which are used as wet treatments, gave about the same degree of control as the copper carbonates.

A study of the stand in the field was made to determine the effect of the treatment on the germination of the seed. Formalin reduced the germination about 20 per cent, while with the other substances no unfavourable effect was noted. Under greenhouse conditions the organic mercury compounds even stimulated seed germination. It was further shown that copper carbonate may be applied to the seed without any injurious effects at least six weeks before seeding.

An experiment in the control of covered smut in hulless oats by seed treatment was carried out at Lacombe, Alta. Liberty oats infected with covered smut were dusted with "Corona" and "Mococo" copper carbonates and sulphur dust. While over 75 per cent of the heads were smutted in the untreated plots, "Corona" and "Mococo" carbonates reduced the amount of smut to 2.1 and 0.7 per cent respectively. Sulphur was equally effective; only 2 per cent were found infected.

The experiments with covered smut of oats were carried out on the Experimental Farms at Brandon, Man., and Rosthern, Sask. The oats were artificially smutted, and in appearance resembled the seed threshed from a heavily smutted crop. At Brandon, the variety was Longfellow, at Rosthern, Leader. These varieties are both highly susceptible to covered smut of oats. The results show that formalin only can be relied upon to destroy covered smut in common oats. The other substances tested reduced the amount of smut, but none gave even fair control. Formalin spray treatment seemed to be superior to either the formalin dip or the sprinkle method. In this treatment one pint of formalin is mixed with one pint of water. The grain is turned with a shovel while the solution is sprayed over the seed from a sprayer like those used in applying insecticides or fly oils. Care must be taken to apply the spray very evenly to the seed. A quart of the concentrated spray is sufficient to treat 50 bushels of grain. After the seed is treated it is covered for four or five hours with a canvas, or bags, moistened with the ordinary formalin solution. At the end of that time the grain is ready to sow. A sprayer of the type mentioned may be purchased for 75 cents or \$1.

GAS TREATMENT FOR THE CONTROL OF WHEAT BUNT

For several years a "Gas Grain Pickler" has been on the market in Saskatchewan and Alberta. The manufacturers of the pickler claim that smut in grain may be controlled by treating the seed by the "Gas Grain Pickler" method. An experiment to test this method for the control of wheat bunt was conducted at Indian Head this year. Portions of the treated seed were sown at the Dominion Experimental Farms at Brandon, Man., Indian Head, and Rosthern, Sask., and Lacombe, Alta.

The "Gas Grain Pickler" consists of a perforated iron pipe and a small generator. If a wagon-box is used for treating the grain, the perforated pipe is run through a hole in the tail-board so that the pipe lies along the bottom of the box and midway between its sides. The perforations in the pipe are kept horizontal, the grain being loaded into the box either before or after inserting the pipe. The grain is covered with canvas or bags before treating is begun. The generator is attached to the end of the pipe. Paraformaldehyde is put in the generator cup, which is then screwed into position. Gas is generated by heating this cup from below with a preparation of liquid heat held in another cup. The gas is conducted along the pipe and into the grain. After the grain is treated it is allowed to stand for from 12 to 24 hours. To insure a better distribution of the gas, the generator may be removed from the pipe and a regular pipe cap, to which has been fitted a pneumatic tube valve, is screwed on. An ordinary automobile air pump is then attached and air is forced through the pipe for from 10 to 20 minutes.

In the present experiment, a standard wagon-box was divided into three compartments by Beaver Board partitions. The perforated pipe ran nearly the full length of the box. It was 1 inch from the bottom and 18 inches from the side of the box. After the pipe was placed in position, the two end compartments were filled with clean grain and the central compartment with naturally smutted grain, similar to that used in the other experiments for the control of wheat bunt, to a depth of approximately 18 inches. The grain was then covered with a heavy canvas. Mr. John Fox, the manager of the Gas Grain Pickler Co., supplied the machine and carried out the actual treatment. He used a charge of approximately 2 ounces of paraformaldehyde. The generator was heated for 45 minutes, after which it was taken off and air was forced through the pipe for 15 minutes. After being allowed to stand for 18 hours the grain was sampled. For sampling, the content of each compartment was divided lengthwise, into three equal lots by pushing down into the grain two pieces of Beaver Board. Each lot was again subdivided into three equal sections by taking the grain out in 6-inch layers. Accordingly, a compartment was ultimately divided into 9 sections, each section being the length of the compartment (a little over 3 feet), 1 foot wide and 6 inches deep. Each section of a compartment was numbered. A cross-sectional diagram of a compartment showing the arrangement of the sections is given below.

1	2	3
4	5	6
7	8 x	9

The pipe ran through section 8 at the point marked x. To reduce the number of samples to be grown in the field, the seed in sections 1 and 3 were combined into one sample, and that in 2, 4, 5, 6, 7, and 9, into one sample, while the seed in section 8 was kept by itself. The seed in sample 1, came therefore, from sections farthest away from the pipe while sample 8 was within 6 inches of the pipe. The remaining sections occupied an intermediate position.

In table 46 are given the percentages of bunt that developed in the treated plots compared with the untreated check plot. It is evident that the treatment failed completely to control bunt.

The effect of the treatment on the seed was determined by taking samples, not only from the central compartment, but also from the end compartments which contained clean seed. When the grain was cleared away from the pipe, it was found that the grain within a radius of from one to three quarters of an inch from each perforation was whitened and loosely cemented together by the paraformaldehyde. Some of the paraformaldehyde also remained in the pipe. Because of the greater plumpness of the clean grain, the smutted grain was relatively more compact, causing the deposit on the smutted grain to be somewhat lighter. In table 47 are given the results of germinating the treated seed. Some of the whitened seeds were picked out and sown, but they failed to germinate. The seeds in samples 5 and 6 also contained whitened seed and it is probable that the reduction of germination in these samples was due in a large measure to their presence. In the other sections the germination of seed was affected but little. As only a small quantity of all the grain treated is whitened by the paraformaldehyde, injury from the treatment would easily be overlooked. The unsatisfactory control of wheat bunt afforded by the "Gas Grain Pickler" method is entirely in accord with the results previously obtained by Prof. W. P. Fraser, formerly of the Dominion Laboratory of Plant Pathology, Saskatoon, Sask. (See Reports of the Dominion Botanist, p. 68, 1922, and p. 51, 1923.)

TABLE 46.—SEED TREATMENT FOR THE CONTROL OF BUNT-INFECTED SEED WHEAT TREATED BY THE "GAS GRAIN PICKLER" METHOD

Sample No.	Sections combined to form 1 sample	Percentage of bunt				Percentage stand (a)
		Brandon, Man.	Indian Head, Sask.	Rosthern, Sask.	Lacombe, Alta.	
1	1 and 3.....	15.8	11.9	6.0	19.0	103.0
2	2, 4, 5, 6, 7, and 9.....	13.6	11.4	5.7	16.0	101.5
3	8.....	12.6	8.0	5.1	17.8	90.5
4	Check-untreated.....	15.8	9.6	6.1	18.4	100.0

(a) Average from Brandon, Rosthern, and Lacombe.

TABLE 47.—EFFECT OF THE "GAS GRAIN PICKLER" TREATMENT ON GERMINATION OF WHEAT SEED

Sample No.	Sections combined to form one sample	Percentage germination			
		Clean seed			Smutted seed
		A	B	Av.	
1	1 and 3.....	93.0	89.5	91.3	77.5
2	2, 4, and 6.....	91.5	92.5	92.0	59.5
3	5.....	93.0	90.5	91.8	52.5
4	7 and 9.....	89.0	80.0	84.5	75.5
5	8.....	73.5	56.0	64.8	68.0
6	3" of pipe.....	52.5	27.5	40.0	23.5
7	Check-untreated.....	86.0	95.0	90.5	73.5
8	Whitened seeds.....	1	0	0.5	.....

A—rear compartment. B—front compartment.

VARIETAL RESISTANCE OF OATS TO LOOSE AND COVERED SMUTS

Last year an experiment was begun to test the varietal resistance of oats to covered smut (*Ustilago levis*). This experiment has been continued. The number of varieties under test, however, was reduced from 126 to 47, a great many of the susceptible varieties being omitted. The same varieties were tested also to loose smut (*Ustilago Avenae*), in a parallel experiment.

It seems advisable to summarize the results but briefly until the experiments have been conducted for a longer time. All varieties that were resistant in last year's test appeared resistant in this year's test also. Certain varieties, however, of *Avena sativa* that were resistant to covered smut were found to be moderately susceptible to loose smut.

TABLE 48.—VARIETAL RESISTANCE OF 47 VARIETIES AND SPECIES OF OATS TO COVERED AND LOOSE SMUT OF OATS AT WINNIPEG IN 1926

Species	Number of varieties	Behaviour to covered and loose smuts
<i>Avena brevis</i>	1	Immune to both smuts.
<i>Avena byzantina</i>	6	Resistant to both smuts.
<i>Avena nuda</i>	2	Highly susceptible to both smuts.
<i>Avena sativa</i>	35	9 immune to both smuts; 7 resistant to covered smut, but moderately susceptible to loose smut; and 19 susceptible to both smuts.
<i>Avena sativa orientalis</i>	3	1 resistant to covered smut, but susceptible to loose smut; and 2 susceptible to both smuts.

Seed was dehulled and then artificially inoculated with spores.

Table 48 briefly summarizes the reaction of the 47 varieties and species of oats to covered and loose smut of oats. Seven varieties, namely Richland, Heigira Rustproof, Monarch (rust resistant selection), Minn. 437, Minn. 439, White Tartar, and Green Mountain which have previously been found to be resistant to black stem rust (see Report of Dominion Botanist for 1924, p. 39), were found to be susceptible to both covered and loose smuts. Ten varieties of oats, six resistant and four susceptible, were tested separately to three collections of covered smut made at widely separated places. The characteristic behaviour to smut of the variety, whether it was susceptible or resistant, was the same to the three different collections used. No indication of physiologic specialization was observed in the limited test made.

The varietal resistance of over 100 strains or varieties of barley was tested to covered smut (*Ustilago Hordei*). This smut was originally collected on Junior barley. Very few of these strains became infected. It is possible that the collection of smut was a physiologic form capable of infecting a very restricted number of varieties.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY IN CO-OPERATION WITH THE UNIVERSITY OF SASKATCHEWAN, SASKATOON

(G. B. Sanford, Plant Pathologist, Officer-in-Charge)

The annual loss to the crops of Western Canada, caused by *Ophiobolus cariceti*, *Helminthosporium sativum*, *Fusarium culmorum*, and other foot- and root-rots is very great, and this fact is more and more realized by the average farmer as well as the agronomist. Much of the injury to wheat and other cereals in the field which the casual observer has often attributed to faulty soil conditions is primarily traceable to these and other soil-inhabiting pathogenic organisms. The control of these diseases in Western Canada is most important. The problem, however, is extremely difficult, and much intensive work must be done, before it can be said that even a fair start has been made. Studies in progress at this laboratory for control of these diseases include,—soil management and crop rotation; seed treatment; obtaining varietal resistance; fundamental studies of the pathological and mycological phases of the general problem.

THE "TAKE-ALL" DISEASE

The "take-all" disease was found this year in varying severity in Alberta, as stated under "Plant Disease Survey."

A collection bearing mature perithecia was made in Prince Edward Island and identified by this laboratory.

The intensive survey of the take-all area in Saskatchewan, begun in 1925, was discontinued except to follow up observations on twenty-six representative fields in that district. These are to be studied the next few years to observe the effect of crop sequence and soil management on the disease. This study is to be supplemented by an adequate crop-sequence, soil-management project, laid down in a naturally infested field to which is added an even amount of artificial inoculum. A field test of the varietal resistance of wheat is a part of the above study. The field work is further supplemented by a test made in the greenhouse in pots to determine the longevity of the pathogen in bare organic and mineral soil types. Take-all caused a mild type of seedling blight of wheat in the field, this being the first recorded. One hundred varieties of wheat are being tested for resistance to the take-all parasite in the greenhouse. A similar test is in progress with oats, barley, and rye. Several varieties of wheat appear to show some resistance under existing conditions, including some strains of Marquis and Early Red Fife. It is hoped to use such plants for breeding material.

Laboratory studies under controlled temperature and soil moisture indicate that, under the conditions of the test, the disease develops better in a soil 60 per cent saturated and held between 22° and 27° C, than it does between 12° and 17° C. A soil 60 per cent saturated was more favourable for the disease than one 40 per cent saturated. This conclusion is based on the number of dead plants.

ROOT-ROT OF SWEET CLOVER

Reports of apparent winter killing of sweet clover in Alberta and Saskatchewan were first investigated during May and June. Most of these fields represented a complete loss (many hundreds of acres), notwithstanding the clover went into winter in apparently excellent condition. In most cases killing occurred where ordinary commercial seed of *Melilotus alba* was used. Very little disease was noted on plants from the Arctic strain of sweet clover distributed by the Department of Field Husbandry, University of Saskatchewan. A fungus was associated with the killing in question and this has been isolated in pure culture at this laboratory, where the disease is being studied. A similar fungus was found on both alfalfa and common red clover roots, associated with large lesions on the former, similar to those on sweet clover. The fungus in question is apparently widely distributed, having been found, among other places, at the Dominion Experimental Farms at Rosthern, Indian Head, Lacombe, Lethbridge, the University plots at Saskatoon and Edmonton, and the School of Agriculture at Olds. Plate 15, fig. 1 illustrates the usual type of injury to the roots. This may vary from complete killing to deep or slight lesions on the tap root, which may be wholly or partially rotted off. In the latter case a partial recovery occurs. The lateral roots are often dead. Plate 15, fig. 2 shows the relative amount of diseased and healthy plants from Arctic and commercial seed, respectively, of *Melilotus alba* and from seed of *M. officinalis* var. *albotrea*. These samples were taken from adjacent plots at the University of Saskatchewan, May 11, 1926.

STUDIES IN *Helminthosporium sativum*, P.K. ET B

RELATIVE VIRULENCE OF STRAINS OF *Helminthosporium sativum*

Ten strains of this fungus were tested in the field and greenhouse for relative virulence. The term strain is not used in a biological sense but designates a culture of the fungus isolated from diseased wheat found in a definite section of the province.

In the greenhouse one hundred grains of Marquis, equally distributed among four pots, were used to test each strain. Twenty grams of inoculum grown on oat hulls were mixed with the soil at seed level. Two weeks after seeding the coleoptiles were examined and the lesioning expressed according to McKinney's formula (Jour. Agr. Res. Vol. 26; No. 5, p. 199) giving numerical ratings of 5, 4, 2, and 1 for emergence, seedling blight, severe, and slight coleoptile lesions, respectively.

For the field experiment two varieties, Marquis and Kubanka, were used, allowing two rows for each test. A small quantity of inoculum was placed around each seed when sown. One hundred seeds were placed about two inches apart in each of the inoculated and check rows. The infection rating was calculated as before, giving numerical values of 4, 3, and 1 for emergence, seedling blight, and severe sub-crown lesions, respectively. These results and also those obtained under greenhouse conditions are given in table 49.

Under the conditions of the experiment it would appear that there is a marked difference in the pathogenicity of some of the strains, notably strain 5.

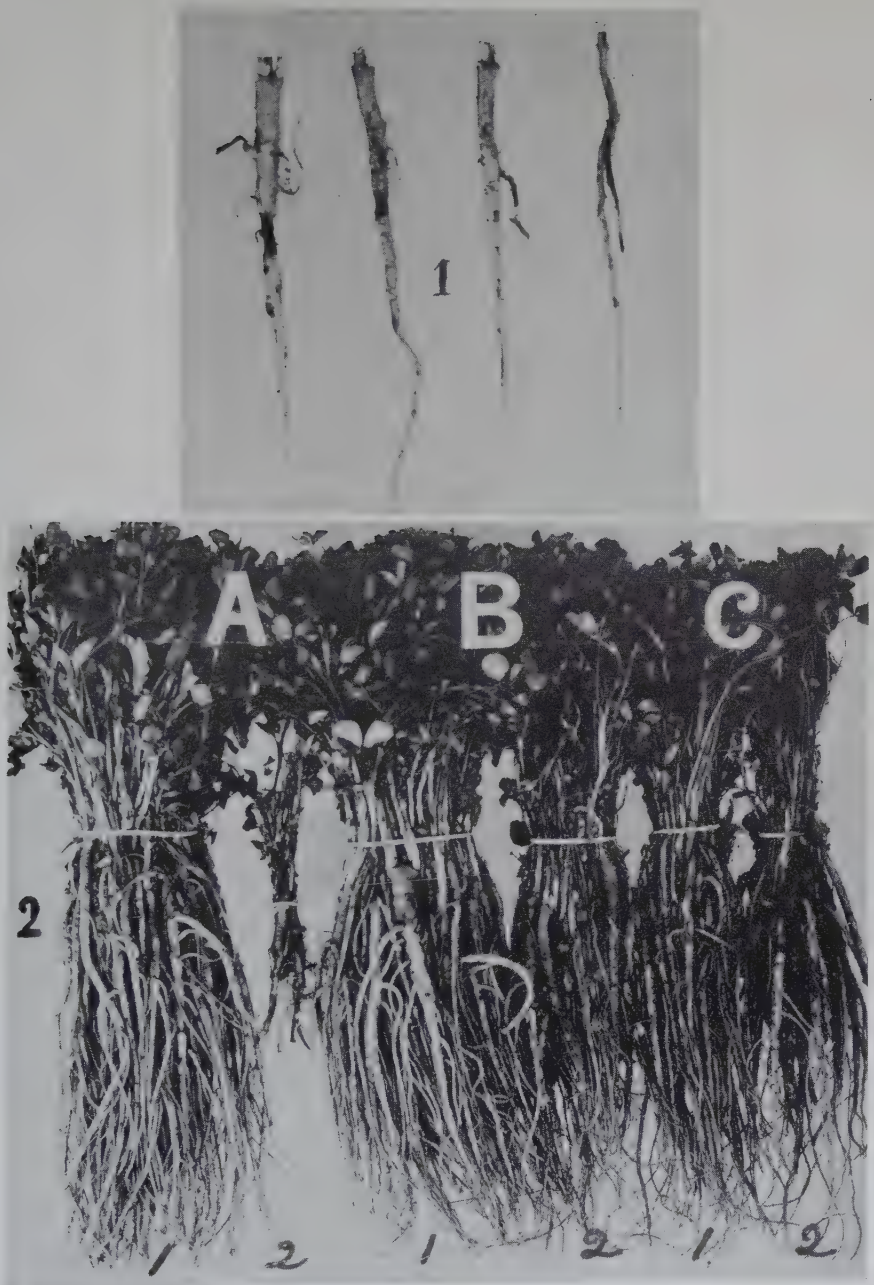


PLATE 15.—ROOT-ROT OF SWEET CLOVER

Fig. 1.—Types of lesions found on the lateral and tap roots of sweet clover.

Fig. 2.—The proportion of healthy (1) to diseased (2) plants in A. *Melilotus alba* (Arctic strain); B. *M. officinalis* var. *albotrea*; C. *M. Alba* (common). The samples were taken from adjacent plots, University of Saskatchewan.

TABLE 49.—THE RELATIVE VIRULENCE OF TEN STRAINS OF *Helminthosporium sativum* AS INDICATED BY THE PERCENTAGE ON MARQUIS AND KUBANKA WHEAT

Strain	Host	Date of isolation	Locality	Infection rating in percentage		
				Field		Greenhouse
				Marquis	Kubanka	Marquis
Check.....				9.0	33.0	2.0
1.....	Wheat seedling.....	1924	Davidson, Sask.....	25.0	52.0	35.6
2.....	Wheat seedling.....	1925	Indian Head, Sask.....	15.2	50.5	54.4
3.....	Wheat seedling.....	1925	Belle Plains, Sask.....	23.5	61.5	77.2
4.....	Wheat seedling.....	1925	Alsask, Sask.....	32.5	62.2	44.0
5.....	Wheat kernel.....	1922	Saskatoon, Sask.....	42.5	84.5	94.4
6.....	Wheat kernel.....	1923	Saskatoon, Sask.....	27.2	60.7	69.6
7.....	Wheat kernel.....	1923	Saskatoon, Sask.....	22.5	60.0	84.4
8.....	Wheat seedling.....	1924	Bulyea, Sask.....	31.5	62.0	68.8
9.....	Wheat node.....	1921	Saskatoon, Sask.....	27.0	58.0	69.6
10.....	Corn leaf.....	1921	St. Paul, Minn.....	53.5	87.0	72.0

INOCULATION METHODS.—An attempt was made to find the best method of distributing inoculum of *Helminthosporium sativum* in pots in the greenhouse to secure infection of the basal parts of wheat seedlings.

The inoculum for each pot consisted of fifteen grams of the most virulent strain (Strain 5) of this fungus, grown on oat hulls. The methods of distribution were as follows:—(A) A layer at seed level mixed with the soil; (B) layers at depths of two, three, and four inches; (C) thoroughly mixed with the soil; (D) a layer on the surface of the soil covered with a thin layer of sand; (E) a small quantity around each seed.

An infection rating of 53.6 per cent was obtained from method C; 36.8 from E; 28.0 from A; 20.0 from D; and 14.4 from B.

DATES OF SEEDING.—A field experiment was conducted to determine the effect of different dates of seeding of Marquis wheat on the infection and disease produced by *Helminthosporium sativum*. May 3, May 15, and June 10 were chosen for seeding to give as wide a variation in soil temperature as possible. On each date a plot consisting of six check and six inoculated rows was sown. One hundred seeds were planted in each row. In the inoculated rows a small quantity of oat hull inoculum was placed around each seed. The rows were planted one foot apart, except that the check rows were separated from the inoculated rows by a 2-foot path. Notes were taken on emergence and seedling blight. The infection rating was calculated as in former field experiments, giving numerical ratings of 2 and 1 for emergence and seedling blight respectively. According to the results there is no appreciable difference in severity of infection for the first two dates of seeding, the infection ratings being 45.7 and 46.2 respectively. A slightly less infection rating of 36.2 was obtained for the seeding of June 10. The lack of greater difference in results may be explained in part by the low soil temperatures at Saskatoon from May to the middle of June. The average soil temperature for that period was 10.1° C. (about 50° F.).

SEASONAL ISOLATIONS FROM WHEAT.—This preliminary experiment was undertaken to determine as far as possible, by means of isolation, the different fungi which attack the basal parts of the wheat plant, and the seasonal variations of these fungi. Special attention was given to the occurrence of *Helminthosporium sativum* and *Fusarium* spp.

Ten rod-rows of Marquis were sown in the University plots on May 3. From the seedling stage on, a representative number of plants were carefully taken up at intervals of one month and platings made from the roots and basal

parts. The method adopted for surface sterilization of the entire basal part was to dip in 95 per cent alcohol, then immerse in mercuric chloride (1-1000) for five minutes, and wash four times in sterile water. The fragments of roots were then trimmed off with sterile scissors, and the respective parts plated out in petri dishes containing potato dextrose agar.

TABLE 50.—THE FUNGI ISOLATED FROM THE BASAL PARTS OF MARQUIS WHEAT AT DIFFERENT TIMES DURING THE SEASON

Date	No. of plants	Part of plant	No. of pieces	Fungous growths			
				Hel.	Fus.	Other types	Undetermined
June 3.....	10	Coleoptile	10	0	0	0	0
		Seed parts	10	0	0	0	0
		Primary roots.	10	0	0	0	0
July 5.....	50	Crowns.....	20	7	5		3
		Stems.....	21	19	0		
		Leaf (bases).....	25	17	2		
		Seed parts.....	15	2	0	1 <i>Rhizoctonia</i> sp.....	5
		Roots.....	10	0	7		1
Aug. 4.....	50	Crowns.....	46	16	15	1 <i>Heterosporium</i> sp.	6
		Roots.....	30	2	17	1 " " 1 <i>Epicoccum</i> sp.	
Sept. 2.....	50	Crowns.....	50	7	26		4
Oct. 4.....	50	Crowns.....	50	12	23		7

This experiment shows some variation in the number and types of fungi isolated as the season advanced. When a variation occurs in such wheat parasites as *Helminthosporium sativum* and *Fusarium* spp., it becomes important to determine this variation over a period of years, in order to ascertain the significance of these fungi pathologically and mycologically. With this in view an experiment on a very much larger scale will be commenced in the spring of 1927.

RESISTANCE OF WHEAT VARIETIES TO *Helminthosporium sativum* AND *Fusarium culmorum*

During this season twenty of the common varieties of wheat were tested in the field and greenhouse for resistance to *Helminthosporium sativum* and *Fusarium culmorum*. The field work was done in co-operation with Dr. J. B. Harrington of the University Department of Field Husbandry.

The following varieties, obtained from the Field Husbandry Department, Saskatoon, were used; Garnet 791, Ruby 48, Quality 1,200, Federation 1,459, Red Bobs 37, Marquillo 1,497, Marquis 70, Ceres 1,212, Kota 673, Early Red Fife 51, Kitchener 34, Red Fife 73, Little Club 1,658, Spelt 606, Emmer 792, Polish 1,273, Peliss 41, Acme 450, Kubanka 6, and Mindum 64.

The greenhouse tests were made in 5-inch pots containing sterilized soil. Twenty-five seeds were sown per pot at a depth of 2 inches. One hundred seeds for each variety were tested against the two pathogens. The pots were inoculated by placing a layer of oat hull inoculum in each pot at seed level. Notes were taken on the number of plants which emerged and the seedling blight. Approximately two weeks after emergence the plants were harvested and notes recorded on the basal lesions found, and the severity of infection expressed in percentage by the usual method.

For the field tests four adequately replicated rows, each 5 feet long, were used. The rows were 1 foot apart, and each contained thirty-five seeds placed about 2 inches apart. A small quantity of oat hull inoculum was placed around each seed at the time of planting. An equal number of uninoculated or check rows were seeded. The *Helminthosporium* section was divided from the *Fusarium* section by a four foot path. Similar notes were taken in the field and greenhouse, with the exception of those on the basal lesions, which were taken when the plants were in the late dough stage.

During the period of the experiments careful isolations were made from the diseased basal parts of plants from each variety, to determine whether the lesions present were caused by the pathogens under study. With very few exceptions the isolations gave positive results.

A summary of results obtained from the field and greenhouse studies is given in table 51. The infection rating for each variety represents the percentage infection as calculated under the conditions of this experiment, minus the infection rating found in the check rows.

TABLE 51.—THE RESISTANCE TO *Helminthosporium sativum* AND *Fusarium Culmorum* OF TWENTY VARIETIES OF WHEAT AS INDICATED BY INFECTION RATING EXPRESSED IN PERCENTAGE. FIELD AND GREENHOUSE TESTS MADE IN 1926

<i>Helminthosporium sativum</i>				<i>Fusarium culmorum</i>			
Greenhouse		Field		Greenhouse		Field	
R. Fife.....	27.2	Ceres.....	23.4	R. Fife.....	49.2	Marquillo.....	8.7
Spelt.....	28.0	Spelt.....	24.1	Kubanka.....	51.7	Ceres.....	9.4
Kubanka.....	41.5	Quality.....	27.5	Acme.....	57.7	Marquis.....	11.2
Polish.....	44.7	Red Fife.....	29.1	E. R. Fife.....	68.7	Spelt.....	13.0
Acme.....	51.5	Acme.....	31.2	Spelt.....	69.0	E. R. Fife.....	15.6
Marquillo.....	52.7	E. R. Fife.....	31.6	Kitchener.....	70.0	Kitchener.....	16.4
Emmer.....	53.0	Emmer.....	33.4	Ceres.....	71.0	Kota.....	16.7
Marquis.....	56.0	Marquis.....	35.2	Peliss.....	72.0	Red Bobs.....	18.0
Kota.....	61.0	Marquillo.....	36.1	Kota.....	75.0	Quality.....	18.5
Kitchener.....	61.2	Kota.....	37.7	Emmer.....	76.0	Acme.....	19.7
Peliss.....	61.5	Federation.....	39.3	Marquis.....	76.2	Emmer.....	19.8
Ceres.....	63.5	Polish.....	42.8	Polish.....	76.7	Little Club.....	21.5
Garnet.....	64.7	Kitchener.....	45.1	Marquillo.....	77.0	Red Fife.....	23.0
Mindum.....	64.8	Red Bobs.....	45.2	Ruby.....	80.7	Peliss.....	23.7
E. R. Fife.....	67.2	Ruby.....	46.5	Mindum.....	81.0	Federation.....	26.2
Ruby.....	69.7	Peliss.....	47.0	Federation.....	81.7	Ruby.....	27.7
Quality.....	74.5	Kubanka.....	51.6	Little Club.....	81.8	Mindum.....	28.0
Little Club.....	75.5	Little Club.....	55.8	Garnet.....	84.2	Polish.....	30.5
Federation.....	75.7	Garnet.....	56.3	Red Bobs.....	87.5	Garnet.....	32.6
Red Bobs.....	78.0	Mindum.....	58.7	Quality.....	90.0	Kubanka.....	35.5

For obvious reasons, conclusions cannot be drawn from a single test. However, the results given in table 51 do indicate that certain varieties have been more resistant under the conditions of the experiment than others. It is also possible that in another year quite different results may be obtained.

BARBERRY AND BUCKTHORN SURVEY

A survey of the principal points in Alberta was made this year, those in Saskatchewan having been practically completed last season. Although a few points remain to be surveyed, especially in Alberta, nearly all the common barberry and buckthorn shrubs in Saskatchewan and Alberta have been located, and the former removed. Barberry plantings located were as follows:—200 feet at Raymond; 100 feet at Claresholm, also 2 bushes at the School of Agriculture there; 25 feet at Lethbridge; 16 shrubs at Brooks; 2 shrubs at Calgary, and 20 shrubs at Edmonton, including 12 at a local nursery. Of all of these three small plantings remain to be taken out early next spring. The barberry hedges at

Raymond and Claresholm bore an abundance of mature fruit. At Claresholm the barberry hedges were heavily rusted, but elsewhere in Alberta and Saskatchewan no rust was noted. No stem rust of wheat was traced to the rusted barberry hedge at Claresholm. Locations of previously removed barberry plantings were visited during the season. (The assistance of E. J. Kiteley, H. S. MacLeod and J. W. Marritt is acknowledged).

Concerning buckthorn plantings in Alberta a total of 2,526 feet of hedge and 70 shrubs have been located at Edmonton, Calgary, Lethbridge, MacLeod, Brooks, and intermediate points on the C.P.R. Fully 82 per cent of these shrubs are in Edmonton, while 7 per cent are in Lethbridge; 5 per cent in MacLeod; 3 per cent in Calgary and the remainder, consisting of individual bushes or, in one or two cases, a hedge, are located at various points. Buckthorn plantings, found in Saskatchewan by 1925 and earlier surveys, consist of approximately 13,805 feet of hedge and 553 bushes; and of these 16 per cent are at Saskatoon; 14 per cent at Regina; 3 per cent at Swift Current; 3 per cent at Estevan; 1 per cent at Moose Jaw; 1 per cent at Weyburn; and the remaining 62 per cent are nearly all in the smaller towns of southern Saskatchewan. No rust was found on buckthorn in Alberta, but slight infections, varying from a trace to two per cent, were noted on these shrubs at Saskatoon, Regina, and Moose Jaw. Crown rust was not reported on oats in Saskatchewan, the season being unfavourable for its development.

In response to our request, 1,227 feet of buckthorn hedge and 30 shrubs have been destroyed in southern Saskatchewan, and more are to be removed next spring. Owners usually ask for compensation, at least to be furnished with shrubs for replacement.

PLANT DISEASE SURVEY

In conjunction with the general rust survey in Saskatchewan and Alberta, and the collection of the first appearance of stem rust on wheat and oats for the Winnipeg laboratory, the severity and prevalence of other economic plant diseases, especially the foot- and root-rots of cereals, were noted. Wherever possible, individual cases reported by farmers were investigated. The Dominion Experiment Stations and the University Farms were visited at least once during the season, and the plant disease problems recorded. The laboratory gave service to a number of farmers of both provinces in answering enquiries regarding seedling blight and foot- and root-rot of cereals, and other crops, and also made isolations from the specimens sent. Mr. W. E. Walker, Provincial District Representative in the Battleford and adjacent districts, deserves special mention for bringing a number of cases of root-rot to our attention. The "take-all" disease was collected at a number of new points in Saskatchewan and Alberta, being found in the prairie as well as in the park region. The severity was greatest in the Camrose district along the Battle River and southward to Meeting Creek. Other foot- and root-rots of cereals, including those caused by *Helminthosporium sativum* and *Fusarium* species, obviously caused a very large financial loss to farmers in Western Canada. Generally speaking there were some areas where these diseases were not as severe as in last season, and vice versa. Apparently climatic factors of temperature and moisture largely account for the variation. Among the areas where these diseases were severe were the Humboldt and adjacent districts westward, including Shellbrook, Blaine Lake, and Battleford in Saskatchewan, and the Camrose, Mirror, Red Deer, and Lacombe areas in Alberta. In addition to these regions there were numerous isolated cases of severity, and also the usual mortality and stunting of individual plants in fields everywhere.

Leaf rust of wheat (*Puccinia triticina*) was general but very light throughout Saskatchewan and Alberta. A trace of stem rust of wheat was collected as far west as Olds and Killam, Alta. Stem rust of oats was not collected in Alberta, but traces of it were observed throughout Saskatchewan. Stripe rust (*Puccinia glumarum*) was collected on a number of wheat varieties at the School of Agriculture, Olds, Alta., this being the first collection made from wheat in Western Canada. Although basal glume rot of wheat was fairly common last season, it was not observed in Alberta or Saskatchewan this year. Officials of the Canadian Seed Growers' Association are much interested in the relation of the discoloured germ ends of wheat grains to the vitality and spread of disease, as it concerns seed registration. This information should be forthcoming as soon as possible. Loose smuts of wheat, oats, and barley, while generally distributed, were not severe. Covered smuts of oats and wheat on the whole were not prevalent, although a number of cases were reported of loss varying up to 25 per cent. Stem canker (*Ascochyta*) of sweet clover was fairly common, but not causing much injury. Stripe rust of barley (*Helminthosporium gramineum*) was fairly common in both Saskatchewan and Alberta. Stem break of flax was common in a number of fields in Saskatchewan, and was found at the School of Agriculture, Olds, Alberta. Generally speaking, common scab (*Actinomyces scabies*) and stem canker (*Rhizoctonia Solani*) of potatoes were probably not more prevalent or severe than usual. The same may be said of mosaic and associated diseases, and blackleg.

The laboratory reported on a large number of fruit and vegetable samples submitted by local agents of the two railway companies. A number of these samples were forwarded by out of town agents. (Acknowledgment is made of the assistance of Mr. B. J. Sallans in the plant disease survey and other work of the laboratory).

INVESTIGATIONS ON THE FOOT DISEASES OF CEREALS IN SOUTHERN SASKATCHEWAN

(P. M. Simmonds, Pathologist-in-Charge)

The work reported here deals chiefly with the foot- and root-rot problems peculiar to southern Saskatchewan, and was formerly given as a report from the Dominion Field Laboratory of Plant Pathology at Indian Head. Field experiments and surveys were carried on at, and from Indian Head, whereas the winter work was done at the Saskatoon Laboratory. Mr. B. J. Sallans, Seasonal Plant Disease Investigator, assisted in the field and greenhouse work.

Most of the work deals with the foot- and root-rot diseases of cereals caused by *Fusarium* spp. Particular studies on *Fusarium culmorum* (W. Smith) Sacc., have been continued. At the Saskatoon Laboratory the writer has collaborated with Mr. G. A. Scott in a study of *Helminthosporium sativum* P.K. et B., as well as in an investigation on the possible resistance of wheat varieties to *Helminthosporium sativum* and *Fusarium culmorum*.

In a season such as last, the cereal crops may show symptoms of root-rot early in the season, but generally recover before much injury has been done. There were cases, however, where a severe retardation of the wheat crop was noticeable. In one such case a *Pythium*-like fungus was found in the roots of diseased plants. Later a rather extensive distribution of this fungus was determined. Furthermore, there was evidence of vascular invading fungi, causing symptoms generally attributable to root-rot. These findings necessarily extend the investigations of foot- and root-rot of cereals, and give some indi-

cation of the complexity of the problem. Control experiments carried on with farmers, as well as general observations, give some promise of control measures through soil management and seed treatments, particularly against the cortex-invading fungi.

STUDIES ON *Fusarium culmorum* (W. SMITH) SACC.

EXPERIMENT I.—A test to determine the effect of the date of seeding of oats and wheat on the infection and disease produced by *Fusarium culmorum*.

METHOD.—Three dates for seeding were chosen so as to give a variation of soil temperature, from the cool temperatures of spring to the warmer soil temperatures of early summer. The plots consisted of three rod rows with one hundred seeds per row. There were four plots, the check and inoculated plots being duplicated. The rows were 1 foot, and the plots 2 feet, apart. The inoculum consisted of a freely sporulating culture of the fungus on a mash of oat hulls. The seeds were sown about two inches deep and, in the case of the inoculated rows, the inoculum after being broken up and mixed was added to the row and in contact with the seed, after which the row was immediately filled in. Notes were taken on non-emergence, seedling blight, and, prior to maturity, one row from a check and inoculated plot was harvested for notes on the amount of basal lesions. Thus there were four types of notes which were given numerical values as 4, 3, 2, and 1, for non-emergence, seedling blight, severe, and slight basal lesions respectively. From these notes an infection rating was worked out on a percentage basis, giving an approximate index of the total disease manifested in each plot.

TABLE 52.—DATES OF SEEDING OATS AND INFECTION RATES

Date	Plots	No. of seeds	Per cent emerg.	Per cent seedl. blt.	Basal lesions		Percentage infect'n rate
					% sev.	% slt.	
May 6.....	Check.....	600	95.4	0.3	6	7	9.5
	Inoc.....	600	88.8	0.1	33	8	29.7
May 24.....	Check.....	600	80.5	0	13	13	20.4
	Inoc.....	600	79.8	0.8	15	17	22.5
June 12.....	Check.....	600	89.6	0	35	19	32.6
	Inoc.....	500	70.5	2.2	38	14	53.6

DISCUSSION.—In the oats there was apparently an increase in the amount of disease towards the later date. This is noticeable only when the total expression of disease, including the checks, is taken into consideration. Inoculations were not distinctly more successful towards the later dates. Isolations have shown that *Fusarium culmorum* was largely responsible for the diseased checks, being presumably natural infections from the soil or seed, probably the former. The soil temperature averaged approximately 15° C. until the latter part of June. At this temperature the pathogen was in all probability not very active, and this may account for the slight amount of seedling blight in each case. Soil moisture was considered good throughout this period. As oat root development progresses well at 15°, this, with an abundance of moisture, probably gave the advantage to the host. There was a sharp increase in soil temperatures after July 1, which would be a factor favouring the appearance of disease in the late sown grain. The wheat plots which were run at Saskatoon did not show suffi-

cient disease for comparison. The low soil temperatures prevalent may explain the lack of infection. Comparatively low soil temperatures prevailing throughout the period of seedling development of cereals in Western Canada, which is not unfavourable to root development, are probably among the important factors in explaining the slight amount of seedling blight in the average season, regardless of the probability of abundant natural inoculum.

EXPERIMENT 2.—Varietal resistance of oats to *Fusarium culmorum*.

METHOD.—In the greenhouse 5-inch pots were used. The soil used was a mixture of a heavy loam and river sand at the rate of five to one. This soil was then sterilized in the autoclave, remixed, and the pots filled. The seeds were planted about 2 inches deep. Seven grams of the oat hull inoculum were added at seed level in the pots inoculated. Sterilized oat hulls, cultures, or plain oat hulls added to the checks did not vary the results, as determined by preliminary tests, so that subsequently the check pots were sown plain. In the field test the method and note-taking were the same as those used in Experiment 1. There were four plots of three rod rows each to each variety. The following varieties were tested. From the Field Husbandry Department, University of Saskatchewan,—Banner 144, Gold Rain 111, Leader 143, Victory 145, and from Dr. D. L. Bailey, Dominion Rust Research Laboratory, Winnipeg,—Heigira rustproof, Joannette, Monarch, Minnesota 437, Minnesota 439 and Richland. In the greenhouse test 250 seeds were inoculated and in the field 600 seeds, with a similar number carried as checks in each case, giving the infection induced by inoculation (the total infection minus natural infection determined by isolations from the checks).

TABLE 53.—RESISTANCE OF OAT VARIETIES AGAINST INOCULATIONS OF *Fusarium culmorum* IN GREENHOUSE AND FIELD TESTS

Variety	Greenhouse test			Field test				
	% emerg.	% seedl. blt.	% inf'n rate	% emerg.	% seedl. blt.	Basal les.		% inf'n rate
						% sev.	% slt.	
Banner.....	14.0	2.0	68.9	67.3	0	35	3	27.0
Gold Rain.....	11.6	1.6	84.8	66.1	0	41	6	35.4
Leader.....	14.8	2.8	71.7	61.3	.6	30	4	13.7
Victory.....	18.0	5.6	81.4	76.4	0	34	15	17.1
Minn. 439.....	22.8	6.8	78.3	72.8	.5	43	15	10.8
Minn. 437.....	15.2	7.6	78.3	67.1	0	34	5	21.5
Monarch.....	47.2	16.8	50.2	91.1	.6	23	9	0
Heigira.....	19.6	7.2	75.4	83.3	0	31	6	9.8
Joannette.....	65.6	1.2	21.3	80.0	0	12	13	14.8
Richland.....	20.0	8.8	76.7	81.6	0	48	4	26.0

DISCUSSION.—In studying varietal resistance against such a versatile fungus as *Fusarium culmorum* one must keep in mind the ever-changing soil, and the sensitivity of both the fungus and the host to their environment. Therefore conclusions drawn from the foregoing tests are considered informative, but not final. It is clear enough that most of the varieties go down severely, especially in the greenhouse. Some of the varieties, however, apparently show some resistance or escape. Monarch and Joannette, two black oats, reveal some such resistance under the conditions of our tests in the greenhouse. Monarch maintained this resistance in the field test, but some of the other varieties showing resistance in the field such as Minnesota 439 and Heigira rustproof went down severely under greenhouse conditions. All of the common varieties are susceptible. It is very probable that resistance to such a parasite is concerned with the anatomy as well as the physiology of the seedling.

PATHOGENICITY TESTS OF *Fusarium* ISOLATIONS

Fusaria have been isolated from wheat, oats, barley, corn, alfalfa, and *Bromus maximus*. In every case, except on alfalfa, they were apparently the cause of, or associated with, a diseased condition of the above hosts. This fungus is so common that in order to restrict the isolations to a reasonable number only apparently parasitic types were cultured. These cultures are single spored and carried until they can be tested in the greenhouse and field. As the study advances it is hoped to have these cultures identified, and to note any correlation between species and types of disease of the major cereal crops.

EXPERIMENT 3.—To determine the amount of seedling blight, and related disease symptoms of oats, wheat, and barley, produced by certain *Fusaria* in greenhouse tests.

METHOD.—Conidial suspensions are made from cultures on potato dextrose agar slants, all cultures being of the same age. Sporulation varied considerably in the cultures being studied, so that those which sporulate weakly are grown on ground oat hulls and introduced as inoculum in this manner, supplementing the suspension test. The seeds were submerged in the suspension and then picked out with forceps and sown. Reasonable measures were taken to avoid contamination. When oat hull inoculum was used it was introduced at seed level and partially mixed with the soil. Five-inch pots were used with fifty seeds to a pot. The soil was not sterilized, but large number of checks were run to determine the possibility of natural infections. Careful isolations were made from doubtful checks, as well as from a sufficient number of the inoculated seedlings, to assist in the proper interpretation of the results.

TABLE 54.—PATHOGENICITY TESTS OF *FUSARIUM* CULTURES USING SUSPENSION INOCULUM

Culture No.	Date isolated	Host	Locality	Infection rate on		
				Oat	Wheat	Barley
				per cent	per cent	per cent
C5.....	1922	Oat foot	Saskatoon.....	78.0	62.7	82.0
71.....	1923	"	Swift Current.....	79.5	41.7	79.2
86.....	1925	"	Goose Lake.....	12.2	8.0	14.2
83.....	1923	Wh. scab	Rosthern.....	82.5	64.0	88.7
73.....	1923	"	Saskatoon.....	59.2	14.5	54.5
80.....	1924	"	Brandon.....	27.7	36.2	27.5
76.....	1923	"	Brandon.....	77.0	73.0	74.5
20.....	1922	"	Tisdale.....	94.2	70.7	94.2
106.....	1925	"	Rosthern.....	88.3	51.7	83.7
105.....	1925	"	Charl. P.E.I.....	28.0	28.2	35.5
90.....	1925	"	Saskatoon.....	75.7	25.5	47.7
90a.....	1925	"	Saskatoon.....	9.7	13.7	23.7
19.....	1922	"	X	28.0	11.0	26.7
77.....	1924	Wh. foot	Saskatoon.....	90.2	21.7	86.2
100.....	1925	"	Indian Head.....	93.7	84.2	94.0
88.....	1925	"	Indian Head.....	87.2	70.7	87.5
98.....	1925	"	Wolseley.....	57.0	21.7	44.0
101.....	1925	"	Indian Head.....	82.7	49.7	76.5
91.....	1925	"	Belle Plains.....	18.5	1.0	21.2
87.....	1925	"	Indian Head.....	22.0	7.2	14.5
25.....	1922	"	Saskatoon.....	26.7	9.7	35.2
99.....	1925	"	Wolseley.....	38.0	12.0	20.0
93.....	1925	"	Belbeck.....	22.5	7.0	16.0
64.....	1923	"	Scott.....	93.7	27.5	87.0
13.....	1921	Wheat	X	18.7	5.5	27.7
96.....	1924	Wh. culm	Saskatoon.....	26.0	18.5	29.7
107.....	1925	Barley ft.	Saskatoon.....	78.2	49.0	81.0
24.....	1922	<i>B. maximus</i>	Manitoba.....	7.2	8.2	16.2
104.....	X	Alfalfa	X	14.7	4.7	9.7
103.....	1925	Corn stalk	Indian Head.....	64.7	44.2	66.2

EXPERIMENT 4.—To determine under field conditions the amount of seedling blight and related disease symptoms of oats, wheat, and barley produced by certain *Fusaria*.

METHOD.—Along with the pathogenicity tests conducted in the greenhouse, selected cultures were tested under field conditions. These cultures were grown on oat hulls; and this inoculum was introduced into the rows to be inoculated at seeding time. The general field plan, technique, and note-taking were the same as for previously mentioned field tests.

TABLE 55.—PATHOGENICITY TESTS OF *Fusarium* CULTURES UNDER FIELD CONDITIONS

Culture No.	No. of seeds tested	Infection rate on		
		Per cent Oat	Per cent Wheat	Per cent Barley
C5.....	600	17.1	6.4	7.2
13.....	600	9.5	3.0	0
19.....	600	9.5	4.9	1.3
90a.....	600	23.3	3.2	0
25.....	600	25.3	13.0	10.6
73.....	600	23.8	3.4	4.6

DISCUSSION.—Under greenhouse conditions it was noted that, as a general rule, where a heavy suspension was used, most disease appeared. There were, however, exceptions. Almost invariably oats and barley were affected more severely than wheat. The type of disease recorded in this test is that of a cortical invasion. Consequently, some of the *Fusaria* which show very little disease may be vascular-inhabiting, and morbidity reactions caused by them are not necessarily manifest in the early seedling stage. The invasion of the vascular system is evident from field specimens; and an investigation to note its significance and relation to *Fusaria* is in the preliminary stage. Many of the cultures studied are of the *Fusarium culmorum* type, and most of these are virulent parasites. This is significant when it is known that this fungus is very common in Western Canada.

When the cultures are tested, using the oat hull inoculum, they conform fairly well with the suspension test; and those which do not sporulate well may show more disease when such inoculum is used. Some, on the other hand, as far as the tests have gone, are weak pathogens in the production of this type of disease under both tests.

Under field conditions the amount of disease in the checks, presumably natural infections, was deducted from the total manifest in the inoculations, and the foregoing table gives the net amount of disease induced by inoculation. Isolations were made from both the check and inoculated plants to assist in the interpretation of results. Generally speaking the oats were most severely affected, while barley was slightly less so than wheat. As mentioned before, the season was not favourable for such disease development. One may deduce from the results, however, the pathogenic nature of the cultures tested; and disease might be more evident under favourable conditions as shown in the greenhouse tests.

EXPERIMENT 5.—Seed Treatments for the Control of Seedling Blight in wheat and oats caused by *Fusarium culmorum*.

Tests were run in the greenhouse to determine the effects of seed treatments against inoculations of *Fusarium culmorum*, and also the stimulatory or protective influence offered against unsterilized soil.

METHOD.—The following wet treatments were used,—Semesan, Germisan, Uspulun, and Tillantin. The seeds were soaked for one hour in the respective solutions and modification thereof, as shown in the following table. The solutions were made up in distilled water. Dust treatments were as follows,—Segetan, Urania, Dupont's Nos. 12, 42, 49, 46, and 57, sulphur (flowers), and lime. For the dust treatments the seeds were shaken up with the dust until coated, avoiding an excess. The ordinary formalin treatment (1-320, soak 5 minutes, cover 15 minutes) was tried as a comparison.

Three tests were run for most treatments, testing one hundred seeds inoculated and in plain soil each time. Five-inch pots were used at fifty seeds per pot. The soil was unsterilized, being one-sixth river sand. The inoculum consisted of a culture of *Fusarium culmorum* on oat hulls, added at seed level.

Sufficient disease was shown in the checks, so that notes were taken only on emergence and seedling blight, then expressed in a percentage infection rate as explained in previous tests. The results are tabulated as follows:—

TABLE 56.—SEED TREATMENTS OF WHEAT IN GREENHOUSE TESTS AS A PROTECTION AGAINST *F. culmorum* AS WELL AS AGAINST UNSTERILIZED SOIL

Treatment	No. of seeds tested	Plain soil			Soil inoculated		
		Per cent emerg.	Per cent seedl. blight.	Per cent inf. rate	Per cent emerg.	Per cent seedl. blight.	Per cent inf. rate
Check.....	300	94.6	0	5.4	51.3	4.3	52.2
Semesan, 0.3.....	300	95.3	0	4.7	94.6	.3	5.6
Semesan, 1.0.....	200	94.5	0	5.5	99.0	.5	1.3
Semesan, 2.0.....	300	92.3	0	7.7	95.5	.6	5.9
Check.....	300	90.6	0	9.4	66.6	5.3	37.4
Germisan, 0.3.....	300	92.6	0	7.4	90.6	0	9.4
Germisan, 1.0.....	300	94.0	0	6.0	96.6	0	3.4
Germisan, 2.0.....	300	86.3	0	13.7	87.3	0	12.7
Uspulun, 0.3.....	300	92.6	0	7.4	91.3	0	8.7
Uspulun, 1.0.....	300	90.6	0	9.4	88.0	0	12.0
Uspulun, 2.0.....	300	92.0	0	8.0	91.0	0	9.0
Check.....	300	94.3	0	5.7	64.3	3.3	38.2
Tillantin, 0.3.....	300	84.0	0	16.0	85.6	0	14.4
Tillantin, 1.0.....	300	90.3	0	9.7	94.6	0	5.4
Tillantin, 2.0.....	300	88.0	0	12.0	86.3	.3	16.2
Segetan.....	300	95.6	0	4.4	96.6	0	3.4
Urania.....	300	96.3	0	3.7	94.0	0	6.0
Dupont, 12.....	300	91.6	0	8.4	96.3	0	3.7
Check.....	300	91.3	0	8.7	68.0	4.3	35.2
Dupont, 42.....	300	49.0	0	51.0	56.0	0	44.0
Dupont, 49.....	300	93.6	0	6.4	89.3	2.3	12.4
Dupont, 46.....	300	89.6	0	11.0	85.0	3.3	17.5
Dupont, 57.....	300	92.0	0	8.0	79.6	1.0	21.1
Check.....	300	90.6	0	9.4	63.6	4.6	39.9
Sulphur.....	100	85.0	2	16.5	15.0	5.0	88.7
Lime.....	100	90.0	0	10.0	33.0	13.0	76.7
Formalin.....	100	78.0	2	23.5	6.0	2.0	95.5

EXPERIMENT 6.—To test the efficacy of some seed treatments of oats under field conditions for the control of seedling blight and lesions caused by *Fusarium culmorum*.

METHOD.—The plots consisted of three rod-rows, one hundred seeds per row but were not duplicated. The general field technique and note-taking were the same as employed for similar experiments mentioned above. All plots were inoculated except check plot No. 1. The results are tabulated as follows:—

TABLE 57.—SEED TREATMENTS OF OATS AGAINST *F. CULMORUM* IN A FIELD TEST

Treatment	Per cent emerg.	Per cent seedl. blight.	Basal lesions		Per cent infection rate	
			Per cent sev.	Per cent slt.	Total	Net
Check, 1.....	95.3	0	4	9	8.9	
Check, 2.....	72.6	1.3	28	3	43.1	34.2
Semesan, 0.3.....	93.6	0	30	11	24.7	15.8
Chlorophol, 0.3.....	87.6	0	16	10	22.9	14.0
Uspulun, 0.3.....	85.0	0	26	3	28.7	19.8
Germisan, 0.3.....	84.6	0	17	6	25.4	16.5
Tillantín, 0.3.....	78.3	0	10	5	27.9	19.0
Sulphur dust.....	69.0	0	24	10	45.2	36.6
Copper carb. dust.....	82.6	0	18	12	29.4	20.5

DISCUSSION.—Seed treatments, to be useful in combating the type of disease under investigation, must give protection to the seedling previous to emergence, particularly, and, in general, ward off possible attacks by soil organisms which may kill or permanently injure the very young plant. There is some evidence in the foregoing tests to show that such protection is offered by certain treatments. In the greenhouse tests Semesan, Germisan, Uspulun, and Tillantin gave very promising results, both against inoculation with *Fusarium culmorum* and in unsterilized soil. Increasing the strength of the solution was not beneficial. The dusts, Segetan, Urania, and Dupont 12, were exceptionally good. Dusts are generally preferred to wet treatments. Sulphur and lime gave very little, if any, control. Formalin treatment revealed more disease than the checks.

In the field test, which was at a disadvantage because of the unfavourable disease conditions, all the treatments, except sulphur, show some control as compared with the inoculated check. The infection rate here depends largely upon severity in appearance of lesions, and error may arise in such cases. It is apparent from the greenhouse tests that some of these treatments are worthy of a large field test, which should be carried out next season.

REPORT OF THE DOMINION FIELD LABORATORY OF PLANT PATHOLOGY, SUMMERLAND, B.C.

(H. R. McLarty, Officer-in-Charge)

FRUIT DISEASES

The winter of 1925-1926 was one of the mildest on record—the lowest temperature recorded at the Experimental Station being 20° F. The cold weather that we did have was accompanied by sufficient snowfall to give protection to the soil and, as a result, we never had more than 2 or 3 inches of frost in the ground. Consequently, the orchards came through the winter in splendid shape, and have produced this season one of the largest crops on record. As might be expected, there was no winter injury; the opposite condition prevailed the year before, and was the limiting factor in the very small crop that was produced that year.

With perhaps one exception, the prevalence of plant diseases was approximately normal. *Fire blight* seemed to be slightly more severe in some localities, while, in others, the losses sustained were considerably less than in former years. *Apple mildew* has practically disappeared, only a few affected twigs having been noticed throughout the season. *Apple scab*, which is not a serious problem in the chief orchard districts, was easily held in check with ordinary sprays, where they were necessary. In the drier sections no spray is needed.

Some noteworthy observations on collar-rot were made. A rapid spread of this trouble was found on trees where no blight could be isolated from the affected tissue and where, considering the light winter, there could have been no winter injury to weaken the trees. It is hoped that a thorough investigation of this problem can be undertaken in the near future.

On the evening of September 22, an exceptionally hard frost occurred, and some apples were so badly affected that they were not picked. As nearly as could be determined, injury sufficient to soften the flesh occurred when the thermometer registered more than 10 degrees of frost.

The one exception where a disease occurred with greater severity than normal was in the case of Corky Core. A survey of the losses sustained this year would indicate that they are much heavier and are more widely spread than usual. A conservative estimate based on information gained from correspondence with packing houses would place the loss at 50,000—75,000 boxes. The extensive losses incurred through this disease make more and more urgent the necessity of exercising every effort to carry on as rapidly as possible our investigation of this problem.

AN INVESTIGATION OF A PHYSIOLOGICAL DISEASE KNOWN AS CORKY CORE

Owing to the continued heavy losses occurring each year because of this disease, it is perhaps advisable at this time to make a statement as to what is being done by this laboratory on the investigation of its causes and control.

In the spring of 1923, which was the year after Salmon Arm district had suffered so severely, an experiment was begun in that district to ascertain the effect of certain cultural methods on the occurrence of the disease. The plan of this experiment and the results obtained to date are reported elsewhere in this report and in previous reports of this laboratory.

In the spring of 1924, a general investigation of the problem was undertaken and eight orchards were procured where an intensive study of all the environmental conditions is being made. This study has been continued since that time with increasing intensity and, during this last summer, approximately 50 per cent of the work being done by this laboratory was put on this problem alone. As is usual in a problem on a physiological disease, it is being found that there are several factors at work which appear to be capable of producing the trouble. A good deal of valuable information has already been brought together, and it is hoped that a definite statement on control measures can soon be made.

AN EXPERIMENT TO DETERMINE THE VALUE OF CERTAIN CULTURAL METHODS IN THE PREVENTION OF CORKY CORE IN APPLES

In this experiment, continued from the previous year, there are four plots of 16 trees each, placed under four different cultural methods as follows:—plot No. 1—a cover-crop of hairy vetch with water; plot No. 2—clean cultivation with the addition of manure and water; plot No. 3—clean cultivation, plus water; plot No. 4—clean cultivation and manure only, no water.

In the spring of 1926, manure was applied to plots numbers 2 and 4 at the rate of 16 tons per acre. During the season only 1 irrigation was applied, this in the latter part of May and early June. A breakdown in the city water system prevented the putting on of later irrigations. The amount applied in this single irrigation was at the rate of 3.6 acre-inches to each of the three plots.

Examinations were made of the fruit on these plots by cutting apples from four sides of each tree. A summary of the results is as follows:—

Plot No. 1—15 trees—

- 8 sides on 6 trees produced apples having corky core.
- 51 sides on 9 trees produced apples having no corky core.
- 1 side on 1 tree produced no crop.

The percentage of the crop having corky core was approximately 13.5.

Plot No. 2—16 trees—

- 39 sides on 15 trees produced apples having corky core.
- 21 sides on 9 trees produced apples having no corky core.
- 4 sides on 3 trees produced no crop.

The percentage of the crop having corky core was approximately 66.

Plot No. 3—16 trees—

- 26 sides on 12 trees produced apples having corky core.
- 37 sides on 13 trees produced apples having no corky core.
- 1 side on 1 tree produced no crop.

The percentage of the crop having corky core was approximately 39.1.

Plot No. 4—13 trees—

- 39 sides on 12 trees produced apples having corky core.
- 12 sides on 6 trees produced apples having no corky core.
- 1 side on 1 tree produced no crop.

The percentage of the crop having corky core was approximately 75.

Check Plot—16 trees—

- 7 sides on 4 trees produced apples having corky core.
- 54 sides on 16 trees produced apples having no corky core.
- 4 sides on 4 trees produced no crop.

The percentage of the crop having corky core was approximately 11.6.

AN EXPERIMENT TO DETERMINE WHETHER FIRE BLIGHT IS SPREAD BY PRUNING TOOLS IF THESE ARE NOT DISINFECTED WHEN USED IN CUTTING DURING THE WINTER SEASON

This experiment was continued along the same lines as in 1925. Inoculations were made by cutting into live cankers with shears or saw and immediately cutting off, with the same tool, a twig or branch. A Winter Bartlett tree, enclosed in a wire-screened cage, was used and 695 inoculations were made on March 19. The buds at this time were showing white over the scales and were quite enlarged.

Careful observations were made during the summer and no infection was found until June 14. On that date 6 twigs showed infection. On June 21, 3 more twigs were found diseased. From a total of 695 inoculations, therefore, only 9 twigs became infected.

LONGEVITY OF FIRE BLIGHT BACTERIA IN IMMATURE FRUIT (Part 1)

As explained in the Annual Report for 1925, on an eight-year-old McIntosh tree ten different apples were inoculated with *B. amylovorus* every week during the growing season. The inoculating needle in each case penetrated to the core.

All of these apples that remained at harvest time were picked and stored until March 30, 1926. On this date isolations for *B. amylovorus* were made.

Whenever white bacterial colonies were obtained from those isolations, inoculations were made on pear seedlings to test the identity of the culture. The results are as follows: from 27 of these apples, white bacterial colonies similar to those of *B. amylovorus* were obtained. To check the identity of these colonies inoculations from 20 of them were made into pear seedlings, and positive results of their being *B. amylovorus*, were obtained in 18 cases. These results are shown in more detail in table 58.

TABLE 58.—TABLE SHOWING ISOLATIONS MADE FROM APPLES FOR *B. Amylovorus*, AND INOCULATIONS MADE INTO PEAR SEEDLINGS

(All isolations made on March 30, 1926)

Date of inoculation into fruit	No. of apples remaining	Isolations	Date of inoc. of isolated organism into pear seedlings	Date of observation	Killing of seedlings
1925			1926	1926	
May 30.....	1	†	May 31	June 10	†
June 5.....	All apples lost	or decayed.			
July 10.....	1	†	May 17	June 12	†
“ 17.....	3	†	“ 17	“ 12	†
“ 24.....	1	†	“ 17	“ 12	†
Aug. 7.....	2	†	“ 17	“ 12	†
“ 14.....	2	†	“ 17	“ 12	†
“ 22.....	6	0	Not tested	Not tested	Not tested
“ 28.....	8	†	May 31	June 11	—
Sept. 10.....	10	†	“ 31	“ 11	†

†—White bacterial colony present.

—No growth.

0—Fungous growth.

It is worthy of note that apples inoculated as early as May 30 produced on March 30 the following year viable cultures of *B. amylovorus*.

The capability of the organism to remain alive in the fruit under the conditions as outlined above seems apparent.

LONGEVITY OF FIRE BLIGHT BACTERIA IN IMMATURE FRUIT (Part 2)

This was an experiment along the lines of the preceding one. On a McIntosh tree five different apples were inoculated every week commencing July 10, 1925. In this experiment, however, a puncture made by the proboscis of an insect was simulated by merely piercing the outer flesh of the apple with the inoculating needle.

As in part 1, isolations were made for *B. amylovorus*. The results are presented in table 59.

TABLE 59.—TABLE SHOWING ISOLATIONS MADE FROM APPLES FOR *B. Amylovorus*, AND INOCULATIONS MADE INTO PEAR SEEDLINGS

(All isolations made on March 30, 1926)

Date of inoculation into fruit	No. of apples remaining	Isolations	Date of inoc. of isolated organism into pear seedlings	Date of observation	Killing of seedlings
1925			1926	1926	
July 10.....	All apples rotted.	†	May 31	June 12	†
“ 17.....	4	†	“ 31	“ 12	†
“ 24.....	2	†	“ 31	“ 12	†
“ 31.....	4	†	“ 31	“ 11	—
Aug. 7.....	1	†	“ 31	“ 11	—
“ 14.....	4	†	“ 31	“ 12	†
“ 22.....	4	†	Not tested	Not tested	Not tested
“ 28.....	5	†	Not tested	Not tested	Not tested
Sept. 4.....	5	†			

†—White bacterial colony present.

—No growth.

0—Fungous growth.

LONGEVITY OF FIRE BLIGHT BACTERIA IN IMMATURE FRUIT (Part 3)

This is an experiment to determine whether fire blight bacteria can enter the calyx-cup of an immature fruit and there remain alive until the end of the storage period.

On a McIntosh tree, ten different apples were inoculated every week during the growing season commencing May 22, 1925. Tested fire blight cultures were used in every case, and the method of inoculation was as follows:—the calyx-end was first sprayed with distilled water from an atomizer; then, by means of a dropping pipette a drop or two of a water suspension of the organism was placed in the calyx-cup.

A total of 150 apples was inoculated, of which, at the end of the storage period, there remained 118 sound apples. On March 30, 1926, isolations for *B. amylovorus* were made, but, in the majority of cases, no white colonies of bacteria were obtained. As described before, inoculations from the few white bacterial colonies isolated were made into pear seedlings, but in no case was there any resultant infection on the young trees.

OBSERVATIONS OF THE LIFE HISTORY AND SPREAD OF PERENNIAL CANKER

(*Gloeosporium perennans*)

Investigations on perennial canker have been continued since last year. The survey work made on the extent of the disease, since its presence in the Okanagan Valley was first discovered, has shown us that it is present in at least four districts, namely, Vernon, Okanagan Centre, Winfield, and Kelowna. Speaking generally, it has not caused serious commercial damage to date. In a few orchards, however, the organism's capability of causing heavy losses is clearly demonstrated. An example of this is to be seen in the Winfield district, where, in a five-acre block of Rome Beauties, the disease has spread so extensively in four years that the production of the orchard has been seriously reduced—so seriously, in fact, that a continuance of its spread at the same rate for four years more would, in the opinion of the grower, necessitate removal of the trees.

STUDIES ON THE LIFE HISTORY OF THE FUNGUS.—During the spring of 1925, a close watch was kept on the cankers, and the approximate date of advance of the fungus into the healthy tissue was determined. It was found in our district that first indications of growth were found early in April, that the growth continued for approximately one month, at which time a distinct crack appeared between the healthy and diseased tissue, and that about one month later the first spores were produced. Germination tests on the spores so produced were begun, and the results during the summer of 1925 and winter of 1926 are presented in the following table. These tests were all made in 2 per cent sugar solution.

TABLE 60.—GERMINATION TESTS—PERENNIAL CANKER—SEASON, 1925

Origin	Date material collected	Date of test	Per cent germination
Orchard 1	May 28	1925 June 10	100
" 1	" 28	" 22	100
" 1	" 28	" 29	100
" 2	June 29	July 1	100
" 1	May 28	" 7	100
" 1	" 28	" 13	100
" 1	" 28	" 20	100
" 1	" 28	" 28	100
" 1	July 18	" 28	100
" 1	May 28	Aug. 3	50
" 1	July 18	" 6	90
" 1	May 28	" 15	50
" 1	July 18	" 15	75
" 1	May 28-2 slides	" 20	50
" 1	" 28-2 "	" 25	90
" 1	" 28-2 "	" 27	70
" 1	Aug. 21-2 "	" 27	75-100
" 1	" 21-2 "	" 31	75
" 1	" 21-3 "	Sept. 3	75-100
" 1	May 28-3 "	" 3	75-100
" 1	" 28-3 "	" 10	90-100
" 1	Aug. 21-3 "	" 10	90-100
" 1	" 21-3 "	" 17	90
" 1	May 28-3 "	" 17	10
" 1	Sept. 27-3 "	" 28	90-100
" 1	" 27-3 "	Oct. 7	90-100
" 1	" 27-3 "	" 13	90-100
" 1	" 27-3 "	" 19	70
" 1	Oct. 20-2 "	" 22	90-105
" 1	" 20-2 "	" 27	90-100
" 1	" 20 "	Nov. 4	70
" 1	" 20-2 "	" 10	90-105
" 1	Nov. 11-2 "	" 16	90-100
" 1	Oct. 20-2 "	" 21	90-100
" 1	Nov. 23-3 "	" 26	90-100
" 1	Dec. 1	Dec. 2	90-100
" 1	" 2	" 3	70
" 1	" 4	" 5	40
" 1	" 7	" 8	90-100
" 1	" 16	" 17	90-100
" 1	Sept. 27	" 19	90-100
" 1	Dec. 21	" 22	90-100
" 1	" 29	" 30	90-100
" 1	1926	1926	
" 1	Jan. 22	Jan. 24	90-100
" 1	Mar. 2	Mar. 2	no germination
" 2	" 5	" 19	50
" 1	April 8	April 13	no germination
" 1	" 20	" 23	"
" 1	" 27	" 29	"

It will be noted that germination takes place quite readily as soon as spores are produced, and continues at approximately 100 per cent throughout the summer, fall, and early winter. It would appear from our results that there is only a very short time, namely, in the spring, when there are no viable spores in the orchard.

INOCULATION RESULTS.—Inoculations were carried out on Rome Beauty trees in the laboratory orchard, commencing May 7, 1925. The following table gives our results of this work.

TABLE 61

Date	No. of inoculations	No. of infections
May	1	0
June	6	2
July	13	1
August	9	4
September	8	2
October	9	7
November	7	7
December	191	178

Some rather interesting facts have been brought to light as a result of this series of inoculations. It was found, for example, that in all inoculations made up until October the fungus made no growth whatever into the bark tissue but did cause a distinct blackening of the heart wood, usually several inches in extent. Inoculations made in and after October showed advances not only in the heart wood but also in the bark where there was produced a brown spot, generally about an inch long and half an inch wide. On all such inoculations left until the spring of 1926, typical fruiting bodies were developed. In the case of the inoculations made before October, however, where no advancement had been made in the phloem tissue, there was no external evidence whatever of infection having taken place when the examinations were made the following spring and summer (plate 16, fig. 1). It was only on cutting into these inoculated points that it was found that infection had taken place at the time of inoculation (plate 16, fig. 2). This infection appeared as blackened tissue running several inches up and down the stem, and from this area (plate 16, figs. 1 and 3), the typical canker fungus has been isolated on several occasions in pure culture. The points of inoculations were healed entirely, a new cambium had been formed (plate 16, fig. 2), and the tissue was functioning in a perfectly normal manner. In fact, in order to uncover the infection, it was necessary to cut through the new wood tissue formed after the inoculation had been made. It would seem then that we can have a limb, infected with a live fungus, able to approach and pass through the period of year during which that fungus ordinarily makes its annual growth, yet without suffering any injury whatever to its essential tissues, providing that a sufficient length of time has elapsed, after the time of infection, to allow for the formation of a protective wood covering. Apparently this protective wood covering is able to prevent the re-entrance of the fungus into the cambium and bark. The point which we would like to stress is that we see from these experiments that the fungus is apparently unable by itself to continue its existence in the live parts of the tree. In other words, left to itself, it would die out completely as a parasite.

OBSERVATIONS ON THE EFFECT OF WOOLLY APHIS ON THE SPREAD OF THE CANKER.—The ability of the tree to recover from infection, demonstrated in the experiments outlined above, naturally led us to an examination of field conditions. Was it possible that all spreading in the cankers in the orchard was, after all, the result of new infections produced each year?

Zeller and Childs* in their bulletin on "Perennial Canker" stated that "there appears to be a possibility of a definite relationship between the woolly aphids to infection and growth of the canker". Our observations lead us to believe that this relationship is a very definite one indeed. During the summer and fall of 1924, the infestation of woolly aphid in the Winfield orchard under observation was extremely severe. It was so bad in fact that the clothing of pickers coming from work in this orchard was blood red from contact with so many insects on the limbs and suckers. In the spring following, there occurred by far the greatest spread of canker recorded to date in that orchard—this in spite of a Bordeaux spray applied during the fall. The early winter of 1924 was remarkable for the very rapid drop in temperature occurring about the middle of December. The extremes of climatic conditions practically wiped out the insect, and, during the summer of 1925, scarcely any aphids could be found. Spore production of the fungus during the summer as a result of the great spread in old and new cankers was at a maximum, and there ought, if natural infection could take place, to have been a heavy infection this spring as a result of last year's canker prevalence. What we found was that there was practically no

*Zeller, S. M. & Leroy Childs, "Perennial Canker of Apple Trees," Oregon A.E.S. Bul. 217, 1925.

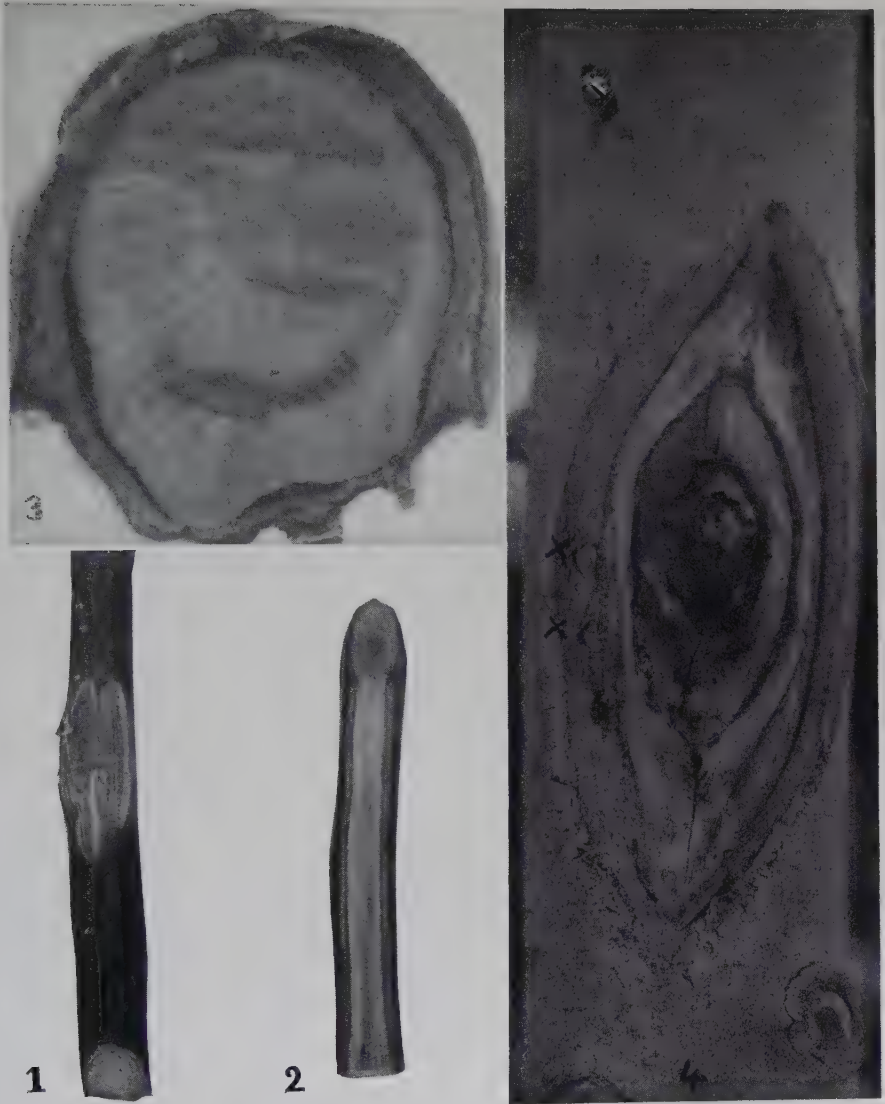


PLATE 16

- Fig. 1.—Twig inoculated with *G. perennans* September, 1925. Photographed June, 1926, after all normal spread in cankers was completed. Note complete healing over at point of inoculation and the black specks on the cut ends showing the extent of spread in the wood tissue. Pure culture was obtained from this blackened area after the photograph was taken.
- Fig. 2.—Longitudinal section of one-half of the twig shown in photograph No. 1. Note blackened tissue running for several inches up the stem from the point of inoculation.
- Fig. 3.—Cross-section of twig shown in photograph No. 1 (enlarged). Note blackened tissue where infection has taken place, and the complete healing over of this tissue with sound wood.
- Fig. 4.—A treated canker of *G. perennans* showing infection caused presumably by 2 aphids which had fed on the callous tissue during the fall of 1925 (marked X). Photograph taken June, 1926, after spread of infection in cankers was completed. Black speck below the two infections was the result of a wound made with a scalpel.

Definite results concerning the effectiveness of these wound dressings in controlling this disease cannot therefore be ascertained this year. While no cases have been observed in which there was evidence that there has been spread of the disease, cankers which were not treated in any way have also shown no spread. Since Woolly Aphis (as explained above) appear to be necessary for infection of the disease to take place, the reason for no spreading in the above experiment becomes apparent.

The apparent necessity of there being Woolly Aphis present on the cankers during the summer and fall, in order to insure spread in those cankers the following spring by the causal fungus, has suggested the need for a covering for the cankers that would keep out the aphis during this period. A refined coal tar*, which had already shown some value of this nature, has been used in the treatment of some 714 cankers in two orchards. Applications have been made at different dates during the summer and fall, and the method of application has been also varied in several ways. Observations on the efficiency of this treatment can be obtained in the spring of 1927.

RESULTS OF SPRAYING EXPERIMENT.—An experiment to determine the efficiency of different spray programs in the prevention of spread of the fungus into new pruning wounds was outlined in the report for 1925. In the spring of 1926, counts were made on wounds of one year's age in the different sprayed blocks and the checks, but it was found that no spread whatever had occurred in pruning wounds in any of these blocks or checks. The absence of woolly aphis during this period suggests an explanation for the results obtained.

POTATO INSPECTION AND CERTIFICATION SERVICE

(John Tucker, Chief Inspector)

In 1915 a system of potato inspection and certification was inaugurated by the Division of Botany in New Brunswick and Prince Edward Island. This work has since been continued and extended proportionately as its value came to be recognized, until now it has become an extremely popular and important branch of this Division, and is now too well known throughout the Dominion to need any further introduction here.

The extent to which this service has grown under the care and guidance of the Dominion Botanist and the limited staff of inspectors is remarkable, when we study the results of the season's work in 1926 compared with some of the earlier years.

It was in 1919 that it was found possible to have a few permanent inspectors who assumed the duties of supervisors, located one in each of the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, and Manitoba. Previous to that the staff was composed mainly of "seasonal" employees.

The work of the seasonal employees was, on the whole, satisfactory, but greater efficiency has undoubtedly resulted since the services of the men, previously appointed for the season and specially trained for the work, have been permanently retained. These same supervisors have stayed with this work from the time they were appointed to the present date, and are now District Inspectors in their respective territories. It has been largely due to their industry and the interest they have taken in the work that we can show such fine results for 1926.

* Used by Leroy Childs of Hood River as a wound covering for protection against perennial canker.

The most gratifying feature of the whole potato inspection and certification work this season is the fact that the demand for Canadian certified seed is improving by leaps and bounds, especially across the border, where our seed enters into competition with the best certified seed produced there, and at prices well in advance of those obtainable for ordinary uninspected stock. Many growers in the Southern States also have now become interested in Canadian-grown seed, and several trial car lots have gone forward this season, which, it is hoped, will result in a profitable business becoming established within the next year or two.

The year 1926 has been a banner one for certified seed potatoes; the total shipments surpass anything we attained before by a very wide margin.

Whereas in 1920 our total car lot shipments of fully certified seed shipped to points outside the Dominion amounted to approximately seventy-five, the shipments during the year 1926 amounted to the huge total of 973,106 bushels shipped under the official certified seed tag, or nearly 1,500 car lots.

The average price paid for this seed would net the growers from \$1.25 to \$1.35 per bushel, whereas the average price paid for table stock for the year 1926 was 88.2 cents (Dominion Bureau of Statistics, January 1927).



PLATE 17.—A field of certified Irish Cobbler seed potatoes. Not one diseased plant found in two inspections. Yield averaged 410 bushels per acre, 70 per cent of which (or 287½ bushels per acre) graded Extra No. 1 Certified Seed.

It is reasonable to assume that approximately one and a quarter million dollars was brought to the pockets of the potato growers of the Dominion in this specialized seed trade, which, it may be stated, would not have been possible but for the pioneer work done on the control of potato diseases, and carried on by the Division of Botany through its pathological and inspectional services. The expense necessary for the upkeep of these departments is, therefore, amply repaid by this one season's results alone.

Considerable responsibility rests with the inspection and certification officials in charge of the work. There must be no slackening up, otherwise this extensive business which has been carefully built up would probably soon crumble away. A business that has arrived in the million dollar class is worth the best efforts of all concerned; and we have not reached the limits of the possibilities of this seed trade by any means yet, for, in addition to the foreign trade,

there is a prospective market for enormous quantities of certified seed potatoes in the Dominion, when more growers realize the importance and even necessity of using seed potatoes free from virus and other diseases. For instance, Ontario and Quebec potato-growers plant every year over three million bushels of seed potatoes, only a very small proportion of which is certified seed. The acreage could be much reduced and yields increased by the use of certified seed. Small acreages with high yields are more profitable than large acreages with low yields.

From our records we find that the certified seed crop of 1926 actually averaged 300 bushels per acre, and many growers reported their crop running over the 400 bushel mark. The average yield of potatoes for all the provinces for the year 1926 was 148.3 bushels per acre (Dominion Bureau of Statistics, January 1927), which is considered a fair average yield.

It should be remembered in this connection that the yield of marketable potatoes per acre and the price per bushel determine the profit in growing potatoes. Not the total production but the yield per acre above the acre cost of producing and marketing the crop is the profit. If it takes a yield of 130 bushels per acre to cover the cost of production, a yield of 150 bushels would therefore mean 20 profit-bushels, and a yield of 300 bushels would mean 170 profit-bushels. In this case the 300 bushel yield would be eight and a half times more profitable than the 150 bushel yield. At this same rate it needs 85 acres of the 150 bushel crop to produce the same profit-bushels as 10 acres of the 300 bushel crop.

In the case of the 85 acres it would be necessary to handle 12,750 bushels of potatoes to reap the same profit as the 10 acres or the 3,000 bushel crop. It is the additional 9,750 bushels of potatoes yielding no profit to the grower which tend to overproduction and low prices prevailing some years.

The seed potato certification work has now got to the point where we must have a satisfactory staff of inspectors, thoroughly trained in all branches of the work, otherwise all our previous efforts may be undone to a considerable extent. We have been particularly fortunate so far in the selection of inspectors, and we hope this good luck may continue, but the growth of the certified seed potato business now warrants more permanent help in some districts.

Included in the two following tables are summaries of the distribution and results of the work in the nine provinces of Canada during 1926, and the average percentages of the principal diseases found in the fields inspected, passed, and rejected:

SUMMARY OF THE INSPECTION WORK BY PROVINCES

	Number of fields inspected	Number of acres inspected	Number of fields passed	Number of acres passed	Per cent fields passed	Per cent acres passed
Prince Edward Island.....	2,300	9,275.0	1,801	7,597.25	78.3	82.0
Nova Scotia.....	137	219.25	106	172.25	77.4	78.5
New Brunswick.....	506	2,031.50	278	1,194.87	55.0	58.8
Quebec.....	184	339.57	107	182.24	58.2	53.6
Ontario.....	440	826.0	319	579.0	72.5	70.1
Manitoba.....	60	146.0	41	100.25	68.3	68.6
Saskatchewan.....	80	213.5	71	102.5	88.75	48.0
Alberta.....	75	152.0	53	56.0	70.6	36.8
British Columbia.....	430	511.75	318	408.25	74.0	79.7
Total.....	4,212	13,714.57	3,094	10,392.61	73.5	75.8

PERCENTAGE OF DISEASE FOUND—By PROVINCES

—	Prince Edward Island	Nova Scotia	New Brun- swick	Quebec	Ontario	Manitoba	Saskat- chewan	Alberta	British Col- umbia
	%	%	%	%	%	%	%	%	%
Average per cent disease in total fields inspected									
Blackleg.....	0.277	0.35	0.37	0.49	0.56	1.12	0.50	1.40	0.28
Leaf Roll.....	0.013	0.74	0.08	0.2	0.48	0.31	0.18	0.17	0.26
Mosaic.....	1.079	0.6	1.6	3.1	0.69	0.26	0.16	0.54	1.35
Wilts.....	0.057	0.03	0.008	0.002	0.0009	0	0	0.06	0.08
Average per cent disease in fields passed:—									
Blackleg.....	0.239	0.25	0.42	0.17	0.41	0.88	0.34	0.27	0.05
Leaf Roll.....	0.007	0.24	0.07	0.14	0.35	0.22	0.14	0.16	0.26
Mosaic.....	0.073	0.016	0.31	0.40	0.5	0.26	0.14	0.13	0.61
Wilts.....	0.035	0.013	0.01	0.004	0.0007	0	0	0.01	0.08
Average per cent disease in fields rejected:—									
Blackleg.....	0.414	0.94	0.32	0.79	1.5	2.32	0.23	3.16	0.92
Leaf Roll.....	0.031	2.02	0.09	0.29	1.3	0.79	0.60	0.21	0.26
Mosaic.....	4.726	3.25	3.22	6.7	1.8	0.28	0.32	1.53	3.4
Wilts.....	0.112	0.06	0	0.003	0.0024	0	0	1.32	0.08

It will be seen by reference to these summaries that 4,212 fields, or 13,714 acres received inspection, and 3,094 fields, or 10,392 acres passed. The corresponding figures for 1925 were: fields 4,542, acres 14,451 entered, and 3,307 fields, 10,856 acres passed.

There was a slight reduction in the number of fields and acres entered for inspection in 1926 compared with 1925, in every province except Prince Edward Island, where 420 more fields were entered than in 1925. This reduction is mostly attributable to the following causes: the attractive prices paid for table stock in the late fall of 1925, and the early spring of 1926, reducing holding for spring plantings to much below normal; the raising of the standard for certification; and the ruling that, to be eligible for certification, necessitated the use of certified seed by the grower.

The results of these changes were good, the amount of low grade stock offered for inspection being reduced without lessening the quantity of certified seed for disposal; and the fact that this increased stringency and reduced acreage have not militated against bona fide seed growers is amply evidenced in the quantity shipped, and in the advance accruing to the grower of over \$1.50 per barrel more than for table stock.

There was a hundred per cent increase in the number of fields entered for inspection in 1924 over 1923, but this was not as desirable as it might appear at first sight. These violent fluctuations are not in the best interests of certified seed production, for many growers are tempted, following a year of high prices, to increase their acreages, more often by the use of uncertified seed, which may contain considerable disease, and which, grown alongside certified seed, will cause disqualification of all the fields. A further slight curtailment of inspection in the direction indicated for 1926 would probably make for sound progress.

A comparison between the work accomplished and results obtained during 1926, compared with 1920, indicates considerable interest and success in the production of certified seed potatoes during that period.

COMPARISON OF FIELD INSPECTION RESULTS 1920-1926

Province	1920			1926		
	Acreage inspected	Acreage passed No. 1	Per cent passed No.1	Acreage inspected	Acreage passed No. 1	Per cent passed No. 1
Prince Edward Island.....	886	523	59.0	9,275.0	7,597.25	82.0
Nova Scotia.....	379	298	78.6	219.25	172.25	78.5
New Brunswick.....	1,413	661	46.8	2,031.5	1,194.87	58.8
Quebec.....	3,868	837	21.7	339.57	182.24	35.6
Ontario.....	472	256	54.2	826.0	579.0	70.1
Manitoba.....	594	275	46.3	146.0	100.25	68.6
Saskatchewan.....	Only preliminary survey work done in the three western provinces during 1920.			213.5	102.5	48.0
Alberta.....				152.0	56.0	36.8
British Columbia.....				511.75	408.25	79.7

1920—7,612 acres inspected. Passed 3,956. 51.9%. No. 1 and No. 2 grades.

1926—13,714.57 acres inspected. Passed 10,392.61. 75.8%. No. 1 grade only.

1920 shipments totalled approximately 75 cars.

1926 shipments totalled approximately 1,500 cars.

From the above analysis it may be stated that this very satisfactory increase in the percentage of acres which passed inspection during 1926 is attributable to the more general use of certified seed in the fields entered for inspection. This feature is particularly outstanding in Prince Edward Island, New Brunswick, and Ontario, where the percentages increased from 59.0 to 82, from 46.8 to 58.48, and from 54.2 to 70.1, and the acreages passed, from 523 to 7,597, from 661 to 1,194.8, and from 256 to 579 respectively. It should be remembered also in this connection that the standard for certification is much higher in 1926 than in 1920, as can be seen by comparing these two standards:—

CERTIFIED SEED POTATO STANDARDS FOR 1920 AND 1926

	1920 Per cent	1926 Per cent Second inspection
Black-leg.....	3	2
Curly dwarf and leaf roll.....	2	1
Mosaic.....	2	1
Wilts.....	3	2
Weak plants.....	3	Not specified.
Foreign.....	5	
Misses.....	Not considered.	$\frac{1}{2}$
Black-leg or wilts alone.....	7	2 (unless due to mechanical causes). Providing that not more than a total of 4 percent be allowed on second inspection. One grade only—No. 1.
Black-leg or wilts combined.....	7	
Leaf roll or mosaic alone.....	6	
Leaf roll or mosaic combined.....	5	
A total of 7 per cent allowed in grade No. 1. In grade No. 2 a total of 12 per cent allowed.		

STANDARD FOR 1927

Owing to the vast territory covered by this work, and in which many and varied climatic and soil conditions prevail, it has been found preferable not to adopt a permanent, unchangeable standard, but, for the sake of uniformity, to revise this year by year should conditions render revision advisable. This annual revision has for its principal object the gradual raising of such standard to the highest possible level to produce seed second to none, to retain and, if possible, increase the demand for certified seed potatoes in foreign markets as well as our own.

CERTIFIED SEED POTATOES—INSPECTION STANDARDS FOR 1927

Field

	1st Inspection Per cent	2nd Inspection Per cent
Blackleg	3	1
Leaf Roll, Curly Dwarf	2	1
Mosaic	2	1
Wilts	3	2
Foreign	1	$\frac{1}{2}$
Misses (if due to roguing)	2	—

Providing that in no case shall a total of more than 6 per cent disease be allowed on first inspection and more than 3 per cent on second inspection.

Tuber

Tags to be issued by inspector only on the express understanding that tubers must conform to the following standard when shipped:—

	Per cent
Wet Rot (Bacterial)	$\frac{1}{2}$
Late Blight or Dry Rot	1
Scabs or Rhizoctonia—	
Slight	10
Severe	5
Nerosis, Wilts, and Internal Discolorations, other than due to variety	5

Providing that in no case shall a total of more than 7 per cent be allowed except in the case of slight scab or Rhizoctonia.

Not more than 1 per cent of Powdery Scab allowed under Scabs.

Not more than 2 per cent of the tubers to be malformed or spindly or badly damaged by sunburn, cuts, cracks, bruises, insects, etc.

No frost injury or foreign tubers shall be allowed.

Not more than 5 per cent by weight of the tubers shall be below three ounces or above twelve ounces.

At fall bin inspection, if more than 3 per cent Late Blight be found in bin, grower will not be allowed to grade for fall shipment but may hold for spring shipment, subject to reinspection.

Potatoes must not be sold as Certified Extra No. 1 seed potatoes unless they have the official Certification Tags attached to the containers.

OFFICIAL TAGS FOR CERTIFIED SEED POTATOES

The official tags in use this year have the same wording and official stamp as before, but, due to the fact that invariably ninety per cent or more of the potatoes certified are of the Irish Cobbler and Green Mountain varieties, it was considered desirable to provide varietal tags, each with a distinctive colouring for these two varieties. The tag for the Irish Cobbler is now yellow, with the lettering "Irish Cobbler" printed thereon in addition to the other printing matter. The tag for Green Mountain is green, with the words "Green Mountain" printed in block letters thereon. The tag for all other varieties remains the same as before.

Purchasers of certified seed should carefully note the tags on seed potatoes when they purchase them, to ensure their obtaining only fully certified seed. There are many imitation tags brought to our notice each year. Some resemble our tags fairly closely, even to the colour and stamp. Needless to say, these other potatoes are inferior to the fully certified potatoes for seed purposes; otherwise, if they could have passed our inspection, they would have been entered for inspection, for there was no charge made to the grower for this service during 1926.

Consideration is being given to the matter of including a paragraph on the back of the official tag requesting the original purchasers of seed potatoes to examine their shipments as soon as received, and, if necessary, notify us immedi-

ately if considered not to grade. Potatoes being of such a perishable nature, it is not fair to our service, if seed potatoes are stored in warehouses and cellars under atmospheric and temperature conditions totally at variance with the normal requirements of the potato, for months after date of inspection, then to expect that they will retain their fine quality and vigour. Potatoes, because they are certified, are not rendered impervious to injury or storge diseases, when subject to adverse conditions. The date on which tags were issued will probably have to be stamped on the front of the tag in future, to assist us to trace shipments and determine how long they have been in storage, when called upon to adjust matters relating to storage damages, lack of vigour, etc.

INSPECTION WORK IN EACH PROVINCE

PRINCE EDWARD ISLAND.—This year comprises the most successful, both from the standpoint of the grower as well as that of the inspection service, that has been experienced since potato inspection became established on the island.

Irish Cobblers continue in greater demand than Green Mountains, 6,841 acres being entered for inspection, of which 6,237 acres or 92 per cent passed.

Green Mountain variety came next, with 2,426 acres inspected, of which 1,264 passed, or 52.1 per cent.

Yields averaged well over 300 bushels per acre for certified seed for both varieties, many fields running over the 400 bushel mark. Some growers were able to grade and ship 250 bushels of certified seed per acre.

The ss. *Sabotawan* loaded on November 26, 1926, at Charlottetown, the largest single shipment of seed potatoes ever carried from any one port in the world—a total of 176,787 bushels. Several other steamers left the same port loaded to capacity with certified seed potatoes. One steamer load left from Georgetown and two schooners from Summerside, all destined for southern ports.

The great bulk of these shipments were made through the Co-operative Potato Growers' Association, which is considered one of the best organizations of its kind in the Dominion.

NOVA SCOTIA.—The Garnet Chili variety certified seed stock continues to give every satisfaction to the Bermuda growers. Approximately 20,000 bushels were shipped during the fall shipping season. More could have been handled if the stock had been available. Unfortunately, the annual controversy over the fixing of a price for this seed stock is endangering this valuable trade (or market).

NEW BRUNSWICK.—The most gratifying and heartening feature of the inspectional activities during 1926 was the readier co-operation and interest manifested by the growers.

Strain tests conducted at Experimental Stations and in Farm Bureau Demonstrations in the United States showed our seed to be superior to most.

The new standard rendered certified seed even more desirable than formerly, and made possible competition with the United States producers. The passed list this season reflects the bona fide seed potato producers of this province.

The outstanding feature of the season's activities is the certification of 58.85 per cent of the acreage of Bliss Triumph inspected. The certification of Bliss Triumph, if present indications materialize, will loom large in the horizon of future season's activities, and a special tag would seem to be expedient.

QUEBEC.—The acreage inspected was considerably below that of 1925, but the percentage of fields and acreage "passed" has increased. One reason for the reduced acreage was that numbers of growers discarded their original seed stocks and started new seed plots to eliminate as much as possible the diseases and foreign varieties in their own stocks. There are many new growers also who have entered with only seed plots using certified seed. The results of these plots are very satisfactory.

The percentage of the acreage inspected in 1926 and planted with Green Mountains was 56.5. A great number of other varieties which have very little commercial value have now been eliminated from our lists.

Approximately 14,000 bushels of certified seed have passed all inspections; of these 9,000 are Green Mountain, 1,600 Carman No. 1, the remainder Irish Cobblers and other varieties.

ONTARIO.—There has been a steady, consistent increase every year since the work started in the production of certified seed in Ontario, until 1926, when the acreage was reduced somewhat. This reduction is in line with the plantings of table stock, which was down somewhat compared with 1925. Possibly the high prices obtained for table potatoes in Ontario during the fall of 1925 and the spring of 1926 caused many growers to oversell, leaving themselves short of seed. It also happened that growers who quoted their certified seed early in the fall could have sold them to better advantage as table stock a month later, owing to the rapid rise in table stock prices.

All the bona fide seed producers stayed with the business, and we are glad to report that the fall shipments were the heaviest we have ever had. Car lot shipments went to Colorado, Minneapolis, New York, Chicago, Arizona, and Indiana, as well as the usual seed trade with southern Ontario from northern points. Interest in the certification work is quite keen, and the quality of our Irish Cobbler seed stock is becoming so well known that the bulk of the Ontario grown certified seed was sold before November 1, even the small whole seed below three ounces being practically all taken, as well as the certified.

The Provincial Department of Agriculture purchased four car lots of certified seed for distribution to the school children, through the Agricultural Representatives Branch, for seed plots.

It is desired to acknowledge here the hearty co-operation of the many provincial officials of the Department of Agriculture, more especially Professor A. H. MacLennan, R. S. Duncan, F. C. Hart, and the Agricultural Representatives, who have consistently supported this work.

PRAIRIE PROVINCES.—In Manitoba there was a slight increase in the acreage entered for inspection, while in Saskatchewan and Alberta there was a decrease. Apparently the decrease was mostly due to the high cost of certified seed in the spring.

Certified seed has given good results in the west, and some seed firms have decided that they will handle only certified seed for their potato trade in the future.

BRITISH COLUMBIA.—The potato inspection and certification work in British Columbia continues to make progress. The Association of certified seed growers, which was organized in 1923, is gradually becoming better established, and it is interesting to note that most of the certified seed potato growers of the province are members of it.

Requests for British Columbia certified seed potatoes are coming in from many sources, particularly from some of the States to the south, such as California and Nevada.

CUBAN SHIPMENTS

Official certificates are required by the Cuban Government for all shipments of potatoes going to Cuba. These are prepared and issued by our district inspectors in the Maritimes, in quadruplicate, as part of their official duties. Up to the end of December, certificates were issued covering 1,211,986 cwt. for shipments in 1926 as follows:—

	cwt.
January.....	240,632
February.....	102,324
March.....	143,985
April.....	44,269
May.....	97,205
June.....	100,702
July.....	22,769
September.....	1,780
October.....	149,101
November.....	153,052
December.....	156,167
	<hr/> 1,211,986

GRADING POPULAR

We are glad to report that the grading of seed stock intended for the season's planting in conformity with requirements for certified seed potatoes is a practice growing in favour. Seed treatment, selection for type, greater care in cutting seed, spraying or dusting, thorough and consistent roguing, maintenance of seed plots, if continued and extended, auger well for the enhancement of the reputation of certified seed potatoes originating in the Dominion.

INSPECTIONAL STAFF

The number of seasonal and temporary inspectors employed this year was 46, including two supplied by the Ontario Department of Agriculture and two by the British Columbia Department of Agriculture. Thus, with the eight district inspectors—including Mr. C. Tice, Provincial Agronomist, Victoria, B.C., who continued to act as district inspector for British Columbia in co-operation with us,—a total of 54 men took part in the work for varying periods. Some of the field inspectors had to return to college in September, and were replaced by other inspectors for the tuber inspection work.

The district inspectors continue to actively co-operate with the provincial departments in delivering addresses on potato diseases, etc., at agricultural meetings, short courses, school fairs, and on field days, and in acting as judges of potatoes at the various exhibitions, and they evidently are giving satisfaction along this line, for their services are in great demand.

Mr. John Tucker, who was appointed inspector for work in Manitoba in 1919, and has been District Inspector in charge of the work in Ontario since 1920 has been appointed Chief Inspector to succeed the late Mr. George Partridge.

It is desired cordially to acknowledge the interest evinced, and the hearty co-operation extended by the provincial Departments of Agriculture, whose officials have rendered every possible assistance towards the successful conduct of the work this past season.

